

UNITED STATES PATENT AND TRADEMARK OFFICE

MIGHTYSLAB DISTRIBUTION COMPANY LLC.

Petitioner

v.

THOMAS GUST
Patent Owner

Case: PGR2026-00074
Patent No. 12,492,151

DECLARATION OF KYLE S. BRINKMAN, Ph.D.

I, Kyle S. Brinkman, Ph.D., hereby declare as follows:

I. INTRODUCTION

1. I have been asked by the law firm of Womble Bond Dickinson (US) LLP, counsel for Petitioner, MightySlab Distribution Company, LLC (“MightySlab” or “Petitioner”) to act as an expert witness in the above-captioned Post-Grant Review (“PGR”) proceeding involving Thomas Gust’s (“Patent Owner”) U.S. Patent No. 12,492,151 (“the 151 Patent”) (EX1001).

2. I have been asked by MightySlab to offer opinions regarding the 151 Patent and claims 1-20 (the “Challenged Claims”) of the 151 Patent, as set forth in the Petition for PGR (“the Petition”). This declaration sets forth the opinions I have reached to date regarding these matters.

3. This declaration contains statements of my opinions formed to date and the associated reasoning in support of my opinions. I reserve the right to offer additional opinions based on further review of the materials of this case, or any related proceedings, including opinions and/or testimony of other relevant witness, including other expert witnesses retained in this matter.

4. The statements contained herein and referenced in the Petition may include my opinion and the bases for my opinions.

5. I am being compensated by MightySlab at my standard hourly consulting rate of \$500 per hour for my time spent on this matter. My compensation is not contingent on the outcome of the PGR or on the substance of my opinions.

6. I have no financial interest in MightySlab or Patent Owner.

A. Qualifications and Experience

7. I have a B.S. in Chemical Engineering, M.S. in Materials Science and Engineering from Clemson University and a Ph.D. in Materials Science and Engineering from Swiss Federal Institute of Technology (EPFL, Switzerland). I served as a postdoctoral fellow at the Advanced Industrial Science and Technology Institute in Japan as part of a program sponsored by the Japanese Society for the Promotion of Science and later worked as a principal engineer in the Science and Technology Directorate of the U.S. Department of Energy's Savannah River National Laboratory. I am a Fellow of the American Ceramic Society (FACERs), a Fellow of the Royal Society of Chemistry in the UK (FRSC), an Academician of the World Academy of Ceramics, and received several awards from professional materials societies. I currently serve as the Department Chair of Materials Science and Engineering at Clemson University since 2019.

8. I have extensive experience in ceramic materials design, processing and characterization. My research is related to the formation, structure and behavior of ceramic composites in diverse application areas including solid oxide fuel cells and

ionic membrane systems, solid-state lithium batteries, and ceramics in energy applications. Specific advances include: i) uncovering a mechanism of enhanced transport at the interface in ceramic composites, ii) compositional development and melt processing demonstration of advanced ceramics for nuclear waste immobilization, iii) development of new compositions and manufacturing routes for high-performance intermediate temperature solid oxide fuel cells, and iv) calorimetry based thermodynamic measurements as predictor for material durability. This body of work has resulted in 6 issued patents.

9. Attached as Appendix A is a copy of my current C.V. further elaborating on my professional background and qualifications.

10. Because of my background, training, and experience, I am qualified to provide the expert opinions within this declaration regarding the technology described and claimed in the '919 Patent.

B. Materials Considered

11. In forming my opinions, I have reviewed the 151 Patent and its prosecution history. I have also reviewed and considered the references cited by the Petitioner, the Petition itself, and other documents and information set forth in this declaration, along with the documents and things contained in the Table of Exhibits provided in the Petition.

12. In reaching my opinions, I have relied upon my experience in the field and also considered the viewpoint of a person of ordinary skill in the art (“POSITA”) at the time of the earliest claimed priority date of the 151 Patent, which I understand to be July 25, 2023. However, my opinion would not change if the challenged claims are found to have a different priority date. As explained below, I am familiar with the level of a POSITA regarding the technology at issue as of that time.

II. RELEVANT LEGAL STANDARDS

13. I am not a legal expert or an attorney, and I am not offering any opinions on the law. While I am not an attorney, I understand that in providing my opinions there are certain principles of patent law that I should apply.

14. I have been informed of and understand the legal standards that apply to patent validity and invalidity, identified below, which I have applied in arriving at my conclusions.

A. Presumption of Validity

15. I understand that patents that have been issued by the U.S. Patent and Trademark Office (“USPTO”) are presumed to be valid, and a party challenging the validity of claims of an issued U.S. patent before the USPTO bears the burden of proving invalidity by a preponderance of the evidence.

B. Claim Construction

16. I have been informed of and understand that claim terms must be properly construed before assessing patentability. I also understand that the words

of a claim are generally given their plain and ordinary meaning, which is the meaning the words would have had to a POSITA at the time of the invention.

17. I understand that the claims do not stand alone and that the plain and ordinary meaning should be harmonized, to the extent possible, with the patent specification and the prosecution history of the patent. I also understand that extrinsic sources, such as dictionaries, handbooks, and textbooks, can shed useful light on the proper construction of a claim term.

C. Anticipation Under 35 U.S.C. § 102

18. I understand that a patent claim is anticipated if, as of the critical date—i.e., the effective filing date under the America Invents Act—each and every limitation recited in the claim is found either expressly or inherently in a single prior art reference and arranged in the prior art in the same way as claimed, such that the disclosure effectively puts the public in possession of the invention.

19. I understand that, for a prior art reference to inherently disclose a claim limitation, that limitation must necessarily be present in the prior art reference.

20. I also understand that prior art is the body of knowledge publicly available to a person skilled in the particular art or field of the invention at the relevant time. More particularly, I have been informed that prior art includes a reference that satisfies 35 U.S.C. § 102(a), regardless of whether the reference was actually known to those skilled in the art.

D. Obviousness Under 35 U.S.C. § 103

21. I understand that, even if all elements of a patented invention cannot be found in a single item of prior art, a claim may nevertheless be unpatentable if the claimed invention would have been obvious as of the critical date—i.e., the effective filing date under the America Invents Act—to a POSITA in the field to which the claimed subject matter belongs.

22. I understand that the following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; (3) the level of ordinary skill in the pertinent art; and (4) the existence of objective evidence or “secondary considerations” of non-obviousness, when present.

23. I understand that indicia of non-obviousness, or “secondary considerations,” may include commercial success, unexpected results, long-felt but unsolved need, industry acclaim, simultaneous invention, copying by others, skepticism by experts in the field, and failure of others. I further understand that any secondary considerations should be connected, or have a “nexus,” to the claimed invention.

24. I understand that a reference qualifies as prior art for obviousness purposes when it is analogous to the claimed invention. I understand that art is analogous if it is either (1) from the same field of endeavor, regardless of the problem

addressed, or (2) reasonably pertinent to the particular problem with which the inventor was involved.

25. I understand that a POSITA is presumed to have knowledge of all relevant prior art and may combine prior art references based on the teachings of those references, general knowledge in the art, or common sense.

26. I understand that a motivation to combine references may be implicit in the prior art and that there is no requirement for an actual or explicit teaching to combine two references. In evaluating obviousness, one may take into account the inferences and creative steps that a POSITA would employ to combine known elements in the manner claimed.

27. I understand, however, that it is improper to use the claimed subject matter as a template for piecing together components or steps found in separate prior art references. In other words, hindsight derived from the challenged patent may not be used to establish a reason to combine separate prior art references and elements.

28. I understand that, when determining whether a patent claim is obvious, neither the particular motivation for the patent nor the stated purpose of the patentee is controlling. The inquiry concerns the objective reach of the claim.

29. I understand that a claimed invention may be obvious if there existed at the relevant date of invention a known problem for which there was an obvious solution encompassed by the patent's claims. A reason to combine references may

come from sources including market demand, scientific literature, a known need or problem in the field, the teachings of the prior art, the general knowledge of a POSITA, or common sense.

30. I understand that familiar items may have obvious uses beyond their primary purposes and that a POSITA is a person of ordinary creativity who may fit the teachings of multiple references together like pieces of a puzzle.

31. I understand that, when there is a design need or market pressure to solve a problem and a finite number of identified, predictable solutions, a POSITA may have good reason to pursue known options within his or her technical grasp. If this leads to anticipated success, the result may be the product of ordinary skill and common sense rather than innovation.

32. I understand that a claimed combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. Thus, if a POSITA could implement a predictable variation, the claimed invention is likely obvious. Combining embodiments disclosed near one another in a prior art reference would not ordinarily require a leap of inventiveness.

33. I understand that obviousness may be shown by demonstrating that it would have been obvious to modify the teachings of a single prior art reference or to combine the teachings of multiple references. The relevant question is not whether a POSITA could physically combine the references, but whether a POSITA would

have been motivated to do so to arrive at the claimed invention with a reasonable expectation of success.

34. I understand that approaches and rationales that may support an obviousness determination include: (a) a teaching, motivation, or suggestion that would have led a POSITA to modify a prior art reference or combine teachings; (b) predictable variations of known work prompted by design incentives or market forces; (c) combining prior art elements according to known methods to yield predictable results; (d) applying a known technique to a known device, method, or product ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions that would have been “obvious to try” with a reasonable expectation of success; (f) substituting one known element for another to obtain predictable results; and (g) using a known technique to improve similar products, devices, or methods in the same way.

35. I understand that, when determining whether a claimed combination is obvious, the correct analysis is not whether a POSITA, writing on a blank slate, would have chosen the particular claimed combination. Rather, the correct analysis considers whether a POSITA, facing the range of needs created by developments in the field, would have recognized a benefit in selecting the claimed combination.

36. I understand that a claimed invention is nonobvious if, when viewed in light of all the prior art, it would not have been an apparent or predictable solution to a POSITA.

E. Written Description Under 35 U.S.C. § 112(a)

37. I understand that 35 U.S.C. § 112(a) requires a patent specification to contain a written description of the invention. I also understand that the written description requirement is satisfied if a POSITA reading the patent application at the time it was filed would have recognized that the application described the invention as claimed, even if the description did not use the exact words found in the claim.

38. I understand that the written description requirement may be satisfied through descriptive means—including words, structures, figures, diagrams, and tables—that fully set forth the claimed invention.

39. I understand that working examples are not required to satisfy the written description requirement. A claim limitation need not be expressly disclosed in the application as originally filed if a POSITA would understand that the limitation is necessarily implied by that application. I also understand that a patent need not disclose what was already well known in the art to provide a sufficient written description.

F. Indefiniteness Under 35 U.S.C. § 112(b)

40. I understand that 35 U.S.C. § 112(b) requires a patent specification to include claims that particularly point out and distinctly claim the subject matter that the inventor or inventors regard as the invention.

41. I understand that a patent claim is invalid for indefiniteness if the claim, read in light of the specification and prosecution history, fails to inform a POSITA with reasonable certainty about the scope of the invention. I further understand that the degree of certainty required takes account of the subject matter.

III. OVERVIEW OF THE TECHNOLOGY

A. Background

42. The 151 Patent describes a porcelain sheet which has a substrate backing. I will briefly discuss porcelain and substrate backing principles generally. Ceramics including porcelain are engineered inorganic materials produced from mineral raw materials, followed by drying and firing at elevated temperatures to create durable, rigid products suitable for a wide range of applications including architectural applications. Traditional ceramic tiles are commonly manufactured from blends of clay, feldspar, silica, and other mineral additives, while porcelain tiles generally utilize more refined raw materials, smaller starting particle sizes and are fired to higher temperatures, resulting in lower porosity, higher density, greater strength, and improved resistance to moisture penetration. From a materials perspective, porcelain is a “glass/ceramic” composite where substantial vitrification

occurs during processing resulting in lower porosity. Due to their durability, hardness, abrasion resistance, chemical resistance, aesthetic versatility, and long service life, ceramic and porcelain tiles have been widely used for decades in residential, commercial, and industrial settings, including flooring, wall cladding, showers, countertops, and other interior and exterior surface applications. More recently, production of large-format and thin porcelain panels has been demonstrated with the porcelain bonded and supported on a substrate backing material. This multilayer construction may be referred to as a laminated ceramic panel. The 151 Patent focuses on a specific geometry between the porcelain tile sheet and substrate/backing material as described below.

B. Overview of the 151 Patent

43. The 151 Patent is titled “Apparatus and Method for Substrate-Backed Porcelain.” EX1001. It issued on December 9, 2025, from U.S. Patent Application No. 18/461,164, filed September 5, 2023, and identifies U.S. Provisional Application No. 63/515,553, filed July 25, 2023, as a related application. *Id.* at cover. The 151 Patent contains twenty claims, including independent Claims 1, 11, and 13. *Id.* at Claims 1-20.

44. The 151 Patent relates generally to construction materials and, more particularly, sheets of porcelain used as surface coverings. *Id.* at 1:13-15. The Background explains that porcelain is denser and less porous than ceramic, but is

also heavier and more brittle. *Id.* at 1:20-29. According to the 151 Patent, porcelain sheets may fracture during transportation or installation, and larger sheets experience greater stresses from their own weight. *Id.* at 1:9-49. The patent also states that inadequate support during installation may make a porcelain sheet susceptible to settling or fracture and that modifying a porcelain sheet at a job site can cause unintended fracturing. *Id.* at 1:57-2:9. The patent therefore identifies a need to improve porcelain's resistance to fracture during transportation, installation, and thereafter. *Id.* at 2:10-13.

45. To address that stated need, the 151 Patent describes adding substrate to one side of a porcelain sheet to stabilize the porcelain and help it resist fracture. *Id.* at 2:53-57. The patent states that the substrate may permit the use of thinner porcelain, reduce overall weight, improve transportability and handling, permit larger porcelain sheet sizes, simplify installation, and make job-site cutting or resizing easier. *Id.* at 2:57 - 3:20. Figure 1 depicts one disclosed assembly in which a substrate sheet 110 is secured to a porcelain sheet 100. *Id.* at 3:21-22, FIG. 1. The overall concept disclosed "surface covering comprising a sheet of porcelain and a sheet of substrate secured to the sheet of porcelain" is not novel and was well known before the invention disclosure date.

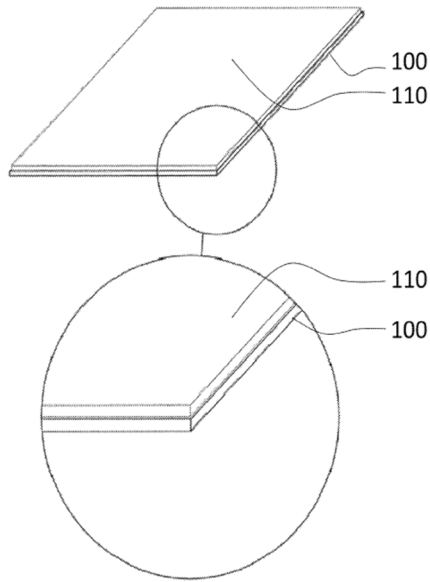


FIG. 1

46. The 151 Patent describes the porcelain sheet as having a size, shape, and thickness selected for its intended application. *Id.* at 3:24-37. Although Figure 1 depicts a rectangle, the patent states that the porcelain sheet may have uneven edges, non-linear edges, or cut-outs; may be as large as 63 inches wide by 126 inches long; and may have any of several disclosed thicknesses. *Id.* The substrate sheet may have dimensions approximately similar to those of the porcelain sheet or may be smaller, including by 1/16 inch along each edge (as depicted in FIG. 1), such that the substrate is inset from the corresponding porcelain edges. *Id.* at 3:38-45. The patent states that this inset “may facilitate better sealing” when adjacent porcelain sheets are installed. *Id.* at 3:45-48. The substrate may be formed from lightweight foam board, may include multiple layers, and may use any of numerous listed foam, polymer, rubber,

or metal-foam materials. *Id.* at 3:53-65. The patent discusses a “recessed” geometry where the substrate size is smaller than the porcelain sheet by specific dimensions of 1/16” along each edge. The specific advantages of such a geometry are stated as “The inset of the sheet of substrate may facilitate better sealing during installation of the adjacent sheets of porcelain.” The disclosed recessed geometry provides for additional volume of sealant underneath the edge of the porcelain sheets. While there is potentially an advantage to extra sealant, the claim is vague and not supported with data. In my opinion, there are equally several disadvantages to this design including potential for the unsupported porcelain sheets to fracture at the edges as well as challenges to obtain proper porcelain to porcelain spacing during installation. Even if there were particular advantages to the recessed geometry as disclosed, the concept of recessed design geometry exists in prior art.

47. In addition, it is unclear what the features of the substrate are desired to create a porcelain, substrate laminate- the listed potential substrates include metal, foam, rubber, polymer which are different material classes with different surfaces which impact the resulting porcelain substrate laminate product. In general, one makes a composite resulting in a new “material” resulting from this combination to access properties which are difficult to achieve with a single material. In the present case, general claims of adhering a porcelain to a wide range of substrate materials with different properties are expected to result in different laminate properties. Since

no quantitative target for properties or performance has been specified it is unclear what is being claimed and why.

48. Figures 2 through 4 illustrate the disclosed process for joining the porcelain and substrate sheets. Figure 2 depicts adhesive 220 being sprayed onto the unfinished or back side 202 of a porcelain sheet 200 and onto a surface of a substrate sheet 210. *Id.* at 4:1-27, FIG. 2. The joining of porcelain and ceramics to a substrate backing is the process of creating a laminate. This is a well known and established concept. Specifying a spray process as well as application to the back side of a porcelain sheet are not unique, patentable methods.

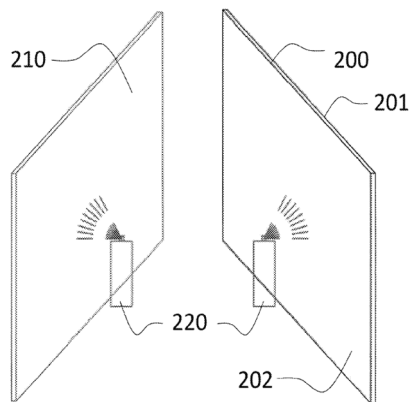


FIG. 2

49. The patent identifies several possible adhesive forms, types, and chemistries and states that the adhesive may be water or temperature resistant. *Id.* at 4:15-27.

50. Figure 3 depicts positioning the substrate sheet 310 adjacent to the porcelain sheet 300 after adhesive application; the sheets may be stacked vertically or horizontally. *Id.* at 4:28-48, FIG. 3. It would be expected to join the substrate and porcelain sheet after adhesive application in order to create a laminate.

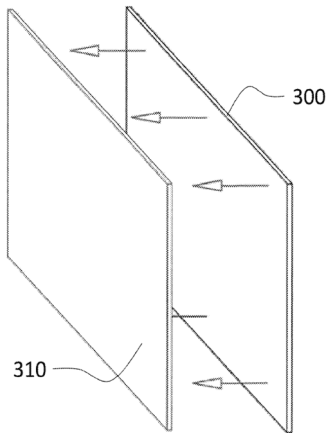


FIG. 3

51. Figure 4 depicts a compression element 430 (e.g., a roller), applying compressive force across the substrate sheet 410 and the porcelain sheet 400 while these sheets are stacked together and rest on a flat supporting surface. *Id.* at 4:49-60, FIG. 4. Moving the compression element 430 across the substrate sheet 410 and porcelain sheet 400 in this manner compresses the sheets to achieve a tight adhesive bond. *Id.* at 4:61-66. The patent specifies “wherein the compressive force is between 30 pounds per square inch to forty pounds per square inch.” It is noted that 30 pounds per square inch is units of pressure (Force/Area) and not a force. It is unclear how this range of pressure was determined for the wide range of laminate material

and adhesive combinations listed. The application of pressure can affect adhesive wetting, void removal, bond-line thickness, and penetration into porous substrates, but it normally does not directly control the chemical reaction of the adhesive. A universal 30 to 40 psi range is therefore difficult to justify across the broad substrate and adhesive choices disclosed unless the patent demonstrates this range produces a critical result.

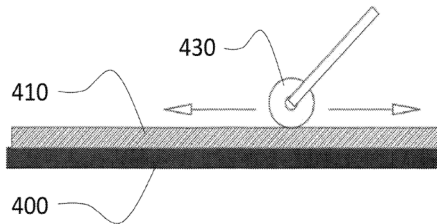


FIG. 4

52. The patent states that the adhesive may cure for between zero and twenty-four hours after compression and that continued compressive force may not be required during curing. *Id.* at 5:4-14. The disclosure of an adhesive cure time ranging from zero to twenty-four hours is technically imprecise and unsupported at its zero-time endpoint. “Cure” ordinarily refers to the progression of a chemical reaction, such as polymerization or crosslinking, by which an adhesive develops its intended mechanical properties. Such a reaction necessarily requires a finite amount of time and therefore cannot have a cure time of zero. The removal of compressive

force is a separate process event and does not establish that the adhesive has cured. An adhesive may develop sufficient strength to hold the porcelain and substrate together immediately after compression is discontinued, while the chemical curing reaction continues for minutes or hours thereafter. Accordingly, a value of zero hours could reasonably mean only that no additional post-compression dwell or clamping period is required, not that the adhesive has completed curing. By describing this interval as a cure time that includes zero, the patent appears to conflate chemical cure with fixture time, handling strength, or the absence of a required post-compression waiting period. While the particular materials being bonded may influence bond strength development and the measured performance of the assembly, a meaningful cure time should generally be associated with a specified adhesive system and defined curing conditions and is typically quantified by achieving some level of strength defined by mechanical property measurements. Another interpretation of zero cure time is a use of a typically weaker bonded pressure sensitive adhesive with no applicable curing at the zero end point of the claim and a separate chemical type of adhesive such as an epoxy which requires time for the reaction to proceed. The claim related to “cure for between zero and twenty-four hours” is imprecise and unclear.

53. Figure 5 depicts adjacent substrate-backed porcelain construction panels 598 and 599—each including a porcelain sheet 500 and a substrate sheet

510—separated by a fill joint 540. *Id.* at 5:14-21, FIG. 5. A sealant dispenser 545 may dispense sealant 547 into the fill joint 540 to prevent moisture, oil, or other substances from passing between the porcelain sheets 500. *Id.* at 5:28-40. Where the substrate sheets 510 have smaller surface areas than the porcelain sheets 500, the patent explains that the gap between adjacent substrate sheets 510 may be larger than the gap between adjacent porcelain sheets 500, which may provide “a better, more resilient seal” and “a more finished appearance.” *Id.* at 5:41-49.

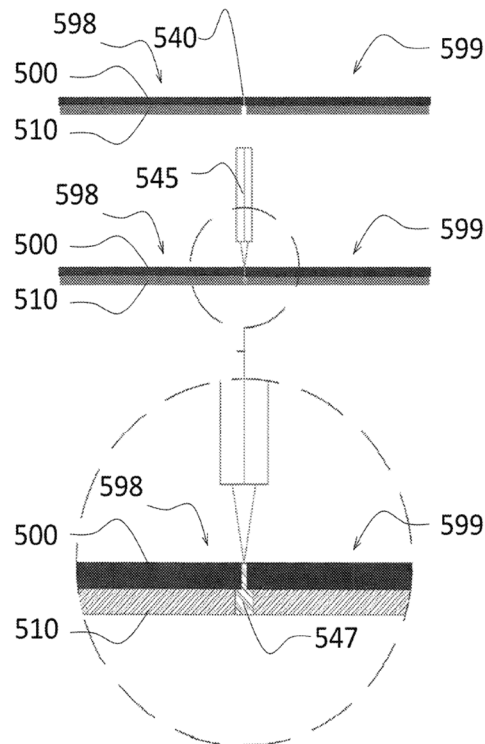


FIG. 5

54. Independent Claims 1, 11, and 13 recite methods of joining a porcelain sheet to a substrate sheet or foam board. Claim 1 requires applying adhesive to the

porcelain sheet's back side, stacking the porcelain sheet and substrate sheet with the porcelain sheet's back side facing a side of the substrate sheet, and joining those surfaces; it further recites that the substrate sheet is between zero and one-eighth inch "different in length and width than the porcelain sheet" and that "the porcelain sheet does not adhere to a side surface of the substrate" while the substrate and porcelain sheets are joined. Claim 11 recites a method "consisting of" selecting a porcelain sheet and foam board, applying adhesive to the porcelain sheet's back side, stacking and joining the sheets with the porcelain sheet's back side facing the foam board's back surface, and ensuring that the porcelain sheet does not contact the board's side surfaces. Given that the porcelain is a hard, brittle ceramic material in the form of a flat sheet, it is unclear under what circumstances the porcelain sheet could conceivably come into contact with the recessed substrate board side surfaces. Claim 13 recites selecting a foam board "up an eighth of an inch different in length and width than the porcelain sheet," applying adhesive, locating the sheets adjacent to one another, and applying compressive force to adhere them; it also recites that the foam board is up to one-eighth inch smaller than the porcelain sheet and that the porcelain sheet does not contact the board side surfaces.

55. The dependent claims add limitations specifying the adhesive is waterproof, the substrate sheet is a foam board, the compressive force is applied across the entire substrate sheet, the compressive force or pressure range of about

thirty to about forty pounds per square inch, the compressive force is not applied while the adhesive cures, cure-time ranges, the substrate's relative weight or composition, and horizontal positioning of the sheets. EX1001 at Claims 2-10, 12, 14-20. Water resistance depends on the particular adhesive chemistry and formulation, degree of cure, bond-line thickness, adhesion to the selected porcelain and substrate surfaces, substrate composition and porosity, surface preparation, edge and joint configuration, and the duration and conditions of water exposure. Foam boards can differ substantially in polymer composition, density, cell structure, facings, water absorption, and compatibility with a particular adhesive. Similarly, an adhesive that resists occasional moisture exposure may not maintain adhesion, cohesive strength, or dimensional stability under prolonged immersion, hydrostatic pressure, thermal cycling, or repeated wet-and-dry exposure. The claims do not identify a particular adhesive chemistry, a quantitative water-exposure condition, an acceptable loss of bond strength, or a test method by which "waterproof" performance is determined.

56. Based on my review of the 151 Patent, I cannot identify a clearly articulated technical invention beyond the particular recessed relationship between the porcelain sheet and the substrate. The general concept of forming a laminate by adhesively bonding porcelain or ceramic material to a supporting substrate was already known, as were the ordinary manufacturing steps of applying adhesive,

bringing the components together, applying pressure, and permitting the adhesive to cure. The 151 Patent broadly encompasses materially different substrates, including foams, polymers, rubber, and metal foams, as well as unspecified adhesive chemistries and processing conditions, without identifying a common quantitative performance objective or explaining how those substantially different combinations produce the same intended result. Several additional limitations, including a pressure of approximately thirty to forty pounds per square inch, cure periods ranging from zero to twenty-four hours, and use of a “waterproof” adhesive, are not tied to a specified adhesive-substrate system, test method, or demonstrated performance threshold. The best I can determine is that the asserted point of distinction is the geometry in which the substrate is the same size as, or up to one-eighth inch smaller than, the porcelain sheet, such that the substrate is recessed from the porcelain perimeter and does not contact or adhere to the substrate side surfaces. The patent suggests that this geometry may provide additional space for sealant between adjacent panels, but it does not provide quantitative testing demonstrating improved sealing, fracture resistance, or other unexpected performance attributable to the claimed dimensional range. Indeed, recessing the substrate leaves a portion of the brittle porcelain edge unsupported and may introduce competing disadvantages, including increased susceptibility to edge chipping or fracture and greater difficulty controlling spacing between adjacent porcelain sheets. Accordingly, from a

technical perspective, it is unclear whether the 151 Patent is intended to cover the general practice of producing a substrate-backed porcelain laminate, a particular manufacturing process, or only the disclosed recessed-substrate geometry.

C. Relevant Prosecution History of the 151 Patent

The 151 Patent is titled “Apparatus and Method for Substrate-Backed Porcelain” and names Thomas Gust as the sole inventor. Ex. 1001 at cover. It claims priority to a provisional application filed July 25, 2023, and issued on December 9, 2025. *Id.* at cover. The non-provisional application was filed September 5, 2023. The Examiner initially rejected all elected claims under as obvious over Calvo in view of U.S. Patent No. 4,140,837 to Drees, finding that Calvo disclosed a porcelain-and-substrate laminate and that Drees supplied the missing adhesive-application step. First Office Action (Non-Final Rejection) (Mar. 7, 2024), Ex. 1002 at 329-33. Applicant responded in April 2024 by amending claim 14 (issued as claim 13) to add a substrate-sizing limitation requiring the substrate to be “between about one-sixteenth of an inch and one-eighth of an inch *smaller* in length and width than the porcelain sheet,” and by adding new independent claim 26 (issued as claim 11) using “consisting of” transitional language. Applicant’s Amendment and Arguments (Apr. 16, 2024), Ex. 1002 at 317-19 (emphasis added). Applicant cited this sizing limitation to distinguish the prior art. Applicant Remarks/Arguments on 4/16/2024 Claim Amendments, Ex. 1002 at 320-321.

57. The Examiner issued a first final rejection in May 2024, rejecting claims 14-22 (issued as claims 13-20 and 7) under § 112(a) for lack of written description, finding that the specification “only provides support for 1/16th of an inch, not necessarily 1/8th of an inch”—recognizing the specification’s sizing disclosure as narrow. First Final Rejection (May 16, 2024), Ex. 1002.

58. Applicant then amended claims 8 and 14 (issued as claims 1 and 13) to add a negative limitation that the porcelain does not adhere to or contact a side surface of the substrate, while also adding a sizing limitation in claim 8 (issued as claim 1) in which “the substrate sheet is between zero and an eighth of an inch *smaller*.” Applicant’s Amendment and Arguments (July 19, 2024), Ex. 1002 at 266-67.

59. Following an appeal and reopened prosecution, the Examiner withdrew the prior § 103 rejections in February 2025 but issued new § 103 rejections on different grounds. Second Non-Final Rejection (Feb. 11, 2025), Ex. 1002 at 139-57. In the Second Non-Final Rejection, the Examiner relied on Yukio for the proposition that a decorative veneer could have “the same size as the upper surface of the substrate,” using it to reject dependent claim 10 (issued as claim 3). *Id.* at 144.

60. Then, in March 2025, Applicant made a critical and unexplained change: in both claims 8 and 14 (issued as claims 1 and 13), Applicant replaced “*smaller*” with “*different*”—broadening the dimensional limitation from a

directional term to a facially neutral one—with no other substantive change to the sizing language. Applicant’s Amendment and Arguments (Mar. 18, 2025), Ex. 1002 at 124-25. Notably, this broadening was not made in response to any rejection of the sizing limitation itself. *See* Second Non-Final Rejection (Feb. 11, 2025), Ex. 1002. Yet in the accompanying remarks, Applicant described the amended claims as requiring the substrate to be “up to an eighth of an inch *smaller*,” as though the word “smaller” still appeared. Applicant Remarks/Arguments on 3/18/2025 Claim Amendments, Ex. 1002 at 128.

61. The Examiner entered the March 2025 amendment without analyzing whether “different” was supported by the specification, stating only that “no new matter” had been added. Second Final Rejection (July 1, 2025), Ex. 1002 at 85. The claims were ultimately allowed in August 2025, with the Examiner’s Reasons for Allowance citing “the claimed size difference between the porcelain sheet and the substrate sheet/foam board” as the distinguishing feature—a rationale that depends on a nonzero difference and is irreconcilable with a zero-difference reading of the claims. Notice of Allowance (Aug. 19, 2025), Ex. 1002.

62. The specification’s technical disclosure is narrow. The Background describes well-known challenges of using porcelain sheets as construction surface coverings—namely, that porcelain is heavy, brittle, prone to fracture during transport and installation, and difficult to cut on a job site. EX1001 at 1:6 – 2:11.

The Summary proposes a single solution: adhering a sheet of substrate (e.g., lightweight foam board) to the back side of a sheet of porcelain to improve fracture resistance. *See id.* at 2:12-30. The Detailed Description elaborates on this concept with limited specificity. It recites broad lists of possible substrate materials, possible adhesive types, possible panel dimensions, and possible thicknesses, but provides no testing data, comparative examples, or empirical support for any particular combination.

63. The specification includes five figures, each depicting a basic step or arrangement in the disclosed process. *Id.* at Figs. 1-5. Figure 1 illustrates a sheet of substrate secured to a sheet of porcelain, with a zoomed-in corner view showing the two layers. *Id.* at 3:21-67, Fig. 1. Figure 2 illustrates adhesive being applied to a surface of both a sheet of substrate and a sheet of porcelain. *Id.* at 4:1-27, Fig. 2. Figure 3 illustrates a sheet of substrate positioned adjacent to a sheet of porcelain for adhesion in a stacking arrangement. *Id.* at 4:28-48, Fig. 3. Figure 4 illustrates a compressive force being applied across the substrate via a roller to bond the substrate to the porcelain. *Id.* at 4:49 – 5:13, Fig. 4. Figure 5 illustrates two adjacent substrate-porcelain construction panels separated by a fill joint, with sealant being applied along the joint. *Id.* at 5:14-65 – 6:19, Fig. 5.

64. While the specification describes the general concept of adhering a substrate sheet to the back of a porcelain sheet and provides broad lists of potential

materials and process options, it provides little explanation for how or why many of the specific dimensional limits, pressure ranges, cure times, and substrate characteristics later recited in the claims were selected. The claims, by contrast, recite specific dimensional constraints and process parameters that find little or no express support in the specification's disclosure. For example, Claims 1 and 13 require that the substrate sheet be "between zero and an eighth of an inch different in length and width" from the porcelain sheet; yet the specification mentions only generally that the substrate "may be slightly smaller" and provides a single example of 1/16-inch inset (*id.* at 3:38-45). The claims also recite a specific pressure range (30-40 psi) (*id.* at Claims 4-5, 15), specific cure times (0-24 hours; 0-10 minutes) (*id.* at Claims 6, 10, 17), and specific substrate characteristics (board that is waterproof, lightweight, and/or foam) (*id.* at Claims 7-8, 11-13, 18-19), drawing largely from broad lists of possible materials, dimensions, and operating parameters rather than from any experimentally supported embodiments.

IV. PERSON OF ORDINARY SKILL IN THE ART

65. I am informed and understand that in the field of patent law, a POSITA is a hypothetical person who is presumed to have known the relevant art at the time of the invention. I understand that the facts that may be considered in determining the level of ordinary skill in the art include: (a) the types of problems encountered in the art; (b) prior art solutions to those problems; (c) the rapidity with which

innovations are made; (d) the sophistication of the technology at issue; and (e) the educational level of active workers in the field.

66. Here, a POSITA at the time of the claimed invention in the 151 Patent would have a Bachelor of Science Degree in Materials Science and Engineering or a related discipline (e.g., chemical engineering, mechanical engineering, construction science, etc.), and at least two years of industry experience related to designing or manufacturing ceramic materials. A POSITA might also have a higher level of training to make up for less education, and vice-versa.

V. CLAIM CONSTRUCTION

67. I have reviewed the Petition's proposed claim construction for the phrase "between zero and an eighth of an inch different" and agree that a POSITA would understand zero to not be included in the claimed range. In order for "different" to have meaning, the size of the substrate must actually be different than the size of the tile, and as I explained above, a POSITA would only interpret the 151 Patent as describing a **smaller** substrate, not a larger one.

VI. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Claims 1-10 and 13-20 Are Indefinite Under 35 U.S. C. § 112(b)

68. In my opinion, independent Claims 1 and 13, and the claims that depend on them, fail to inform a POSITA with reasonable certainty about the required dimensional relationship between the porcelain sheet and the substrate sheet

or foam board. Claim 1 requires the substrate sheet to be “between zero and an eighth of an inch different in length and width than the porcelain sheet,” and Claim 13 requires the foam board to be “up to an eighth of an inch different in length and width than the porcelain sheet.” EX1001 at Claims 1, 13. Neither claim states whether “different” requires the substrate or foam board to be smaller than the porcelain sheet, permits it to be larger, or permits either relationship.

69. The 151 Patent’s specification does not resolve that uncertainty. Outside the claims, the word “different” appears only in descriptions of differences between ceramic and porcelain and of substrate layers made from different materials; it is not used to describe a dimensional relationship. *Id.* at 1:65-66, 3:53-55. When discussing the dimensional relationship between a substrate sheet and a porcelain sheet, the specification discloses only that the substrate sheet “may be sized and dimensions approximately similarly to the sheet of porcelain,” “may be slightly smaller than the sheet of porcelain,” and “may be smaller than the sheet of porcelain 100 (e.g., smaller by 1/16 inches along each edge).” *Id.* at 3:38-43. It further states that each substrate edge may be inset from the corresponding porcelain edge. *Id.* at 3:43-48; FIG. 1. Thus, while the claims recite a substrate sheet that is up to one-eighth inch “different” in length and width than the porcelain sheet, the specification describes dimensional differences only in the direction of a smaller substrate and provides no guidance as to whether the claims’ directionally neutral

term “different” encompasses a substrate that is larger than the porcelain sheet, a substrate that is smaller than the porcelain sheet, or both. In my opinion, these disclosures do not provide a POSITA with an objective basis for determining whether the claims’ directionally neutral word “different” encompasses a larger substrate sheet, a smaller substrate sheet, or both.

70. The prosecution history further compounds this uncertainty. During prosecution, the Applicant amended then-pending Claim 8, which issued as Claim 1, by replacing “between zero and an eighth of an inch smaller” with “between zero and an eighth of an inch different.” EX1002, Applicant’s March 18, 2025 Amended Claims at 1. The Applicant similarly amended then-pending Claim 14, which issued as Claim 13, to recite a foam board “up to an eighth of an inch different in length and width than the porcelain sheet.” *Id.* at 2. Yet, in the accompanying remarks, the Applicant described both amended claims as requiring the substrate sheet or foam board to be “up to an eighth of an inch smaller in length and width than the porcelain sheet.” EX1002, Applicant’s March 18, 2025 Remarks at 1. In my opinion, changing the claim language from “smaller” to “different” while continuing to characterize the claims as requiring a smaller substrate leaves a POSITA without clear guidance about whether the amended claims also encompass a larger substrate.

71. I understand that the Examiner did not address whether replacing “smaller” with “different” created uncertainty regarding the direction of the

dimensional relationship. *See* EX1002, Second Final Office Action dated July 1, 2025 at 3-5. Thus, in my opinion, the prosecution history does not adequately define the claim term “different.”

72. Claim 13 contains an additional internal inconsistency. Its selecting step requires a foam board “up to an eighth of an inch different in length and width than the porcelain sheet,” while a later limitation requires that “the foam board is up to an eighth of an inch smaller in length and width than the porcelain sheet.” Ex. 1001 at Claim 13. If “different” and “smaller” have the same meaning, using both terms to describe the same dimensional relationship creates uncertainty about whether they impose distinct requirements. If they have different meanings, the claim does not explain how a foam board can satisfy both limitations when “different” is read to include a board larger than the porcelain sheet. In my opinion, a POSITA would not have an informed and confident basis for choosing between these readings.

73. Claim 1 contains a separate ambiguity at the lower endpoint of its range. The claim requires the substrate sheet to be “between zero and an eighth of an inch different” in length and width from the porcelain sheet. *Id.* at Claim 1. A zero-inch dimensional difference indicates equal dimensions, while the word “different” indicates some difference. Neither the claims, the specification, nor the prosecution history clarifies whether the recited dimensional “difference” includes a difference of zero, such that a substrate sheet having dimensions identical to the porcelain sheet

would satisfy the limitation. In my opinion, the claim therefore fails to inform a POSITA with reasonable certainty whether the limitation encompasses a zero-inch difference.

74. Claims 1 and 13 also do not specify how their dimensional tolerances apply to length and width. Claim 1 recites “between zero and an eighth of an inch different in length and width,” and Claim 13 similarly recites “up to an eighth of an inch different in length and width.” The claims do not explain whether the recited tolerance applies independently to length and width, collectively across both dimensions, or in some other manner. Nor do the specification or prosecution history provide any guidance on that issue. In my experience, a POSITA in the field of porcelain tile and construction-panel manufacturing ordinarily evaluates product dimensions by separately measuring and comparing a panel’s length and width. Because the intrinsic record supplies no objective standard for making that determination, a POSITA would lack an objective basis for determining whether a particular substrate sheet falls within the scope of the claimed dimensional limitation.

75. The claims also do not require the porcelain and substrate sheets to be rectangular or otherwise to possess readily ascertainable length and width dimensions. The specification expressly states that a porcelain sheet may have “any shape appropriate for its intended use,” including “uneven edges, non-linear edges, [and] cut-outs.” *Id.* at 3:25-30. Neither the claims nor the specification identifies

how “length” and “width” are to be determined for such irregular geometries, including whether those dimensions should be determined using maximum overall dimensions, nominal dimensions, dimensions between particular edges, or some other methodology. In my opinion, this absence of measurement criteria creates further uncertainty regarding how a POSITA should apply the claimed dimensional limitations across the full range of disclosed sheet geometries. For example, where a disclosed porcelain sheet includes “uneven edges” or “non-linear edges,” a POSITA could reasonably employ different measurement approaches, each yielding different length and width values, depending on whether the measurements are based on the sheet’s maximum overall dimensions, the maximum distances between portions of its perimeter, or dimensions of a bounding rectangle encompassing the sheet. The patent provides no guidance for selecting among those approaches. In my opinion, because different measurement methodologies can yield different length and width values for the same disclosed sheet geometry, the intrinsic record provides no objective basis for determining whether a given substrate-and-porcelain-sheet combination satisfies the claimed dimensional limitations.

76. For these reasons, it is my opinion that Claims 1 and 13 fail to inform a POSITA with reasonable certainty about the scope of the claimed dimensional relationship. Claims 2-10 depend from Claim 1, and Claims 14-20 depend from

Claim 13. EX1001 at Claims 2-10, 14-20. Accordingly, it is my opinion that Claims 1-10 and 13-20 are indefinite under 35 U.S.C. § 112(b).

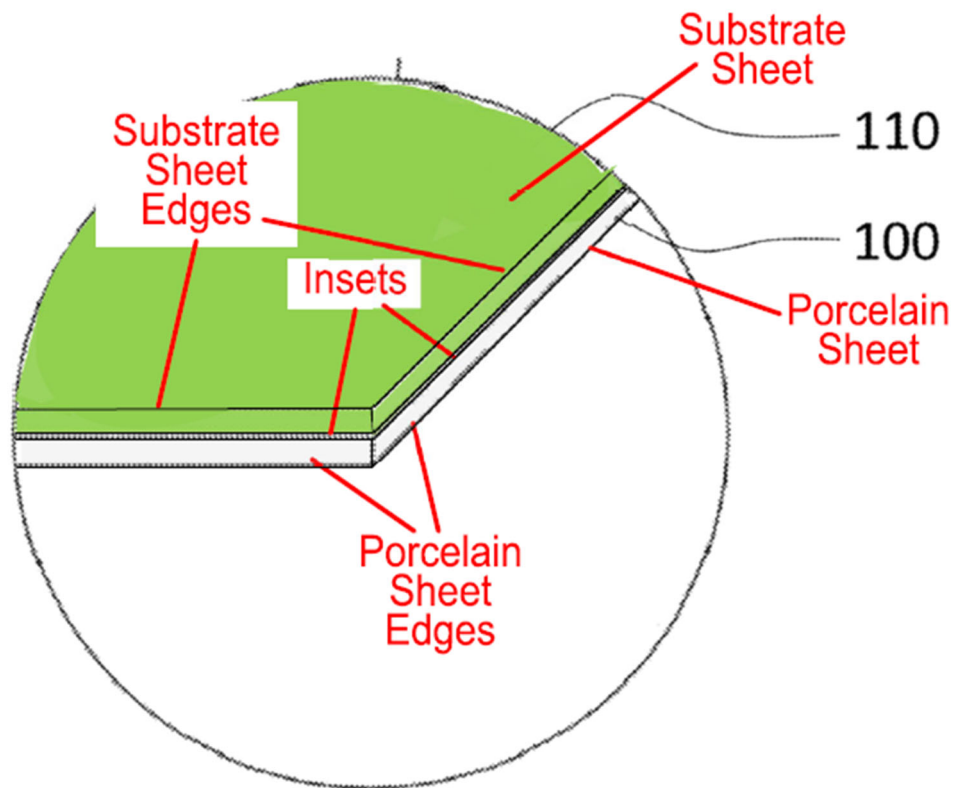
B. Ground 2: Claims 1-20 Lack Sufficient Written Description Under 35 U.S.C. §112(a)

i. Claims 1-10 and 13-20 lack written-description support for the broadened “different” limitation

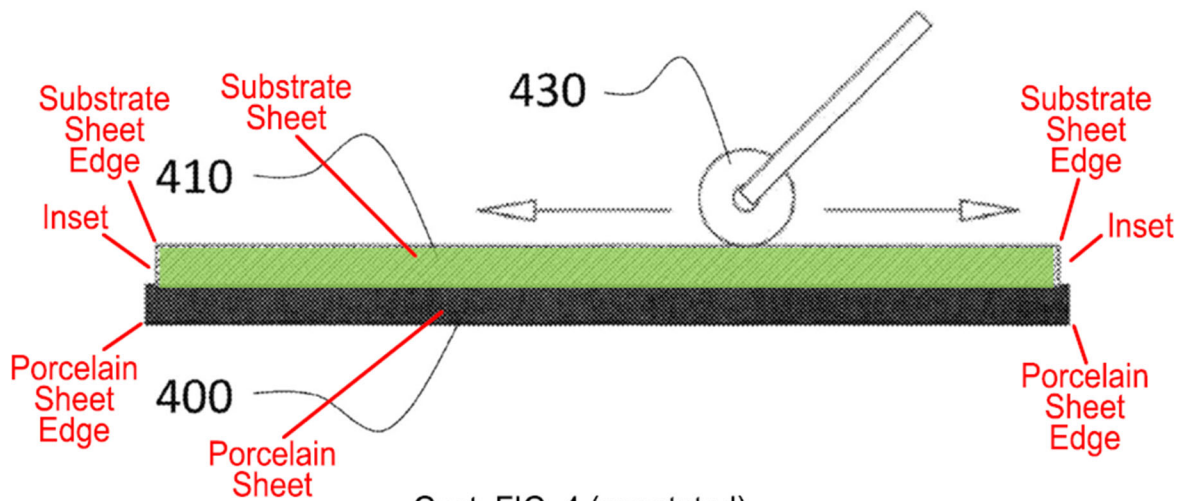
77. In my opinion, Claims 1-10 and 13-20 lack adequate written-description support because Claims 1 and 13 use the directionally neutral term “different” and therefore encompass substrate sheets or foam boards that are either smaller or larger than the porcelain sheet, while the originally filed disclosures describe only approximately similarly sized or smaller substrates. Claim 1 recites that “the substrate sheet is between zero and an eighth of an inch different in length and width than the porcelain sheet,” and Claim 13 similarly recites, in its selecting step, that “the foam board is up to an eighth of an inch different in length and width than the porcelain sheet.” Ex. 1001 at Claims 1, 13.

78. I understand that the written-description inquiry asks whether the originally filed disclosure reasonably conveys to a POSITA that the inventor possessed the full scope of the claimed invention as of the filing date. As discussed above, the specification must describe the claimed invention with all its limitations. In my opinion, the originally filed disclosure does not convey possession of the full, directionally neutral scope introduced by the word “different.”

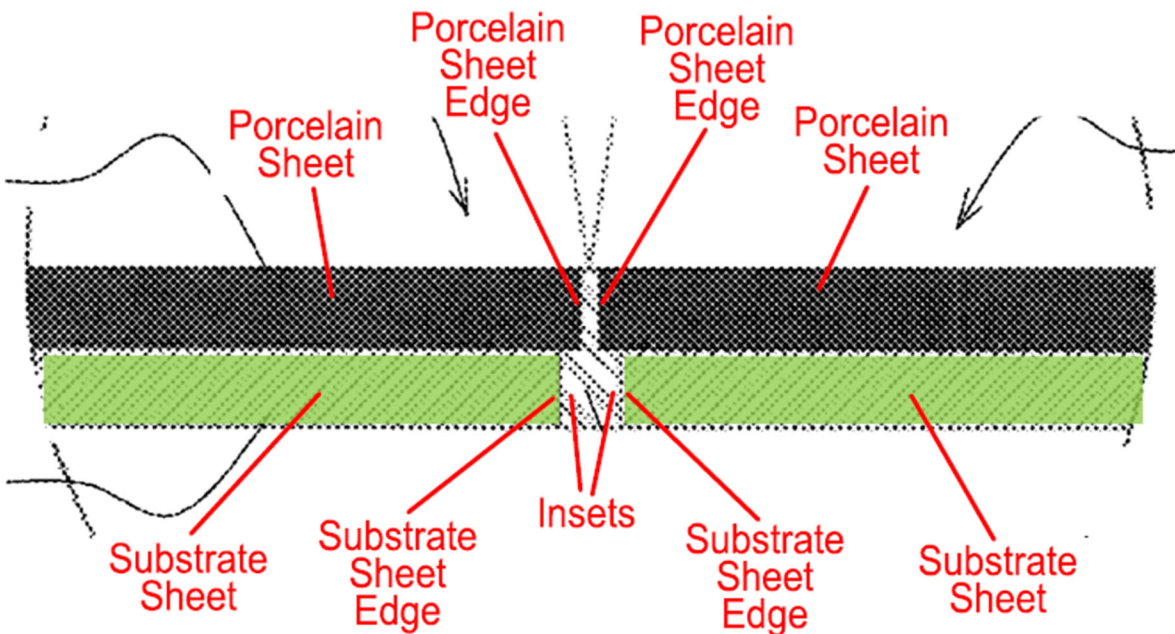
79. The 151 Patent's specification does not describe a substrate sheet or foam board that is larger than the porcelain sheet. Instead, the specification states that the substrate sheet “may be sized and dimensions approximately similarly to the sheet of porcelain,” “may be slightly smaller than the sheet of porcelain,” and “may be smaller than the sheet of porcelain [] (e.g., smaller by 1/16 inches along each edge).” Ex. 1001 at 3:38-43. It further states that each edge of the substrate sheet may be inset from the corresponding edge of the porcelain sheet, and Figures 1, 4, and 5 depict that inset configuration. *Id.* at 3:43-48, FIGS. 1, 4, 5. Thus, every sizing-specific embodiment disclosed in the specification points to an approximately similarly sized or smaller substrate, not a larger one.



Gust, FIG. 1 (partial, annotated)



Gust, FIG. 4 (annotated)



Gust, FIG. 5 (partial, annotated)

80. The word “different” does not supply the missing disclosure. In the specification and applications as originally filed, “different” is not used to describe the relative dimensions of the porcelain and substrate sheets. The word appears only in the Background’s statement that ceramic and porcelain are “quite different” when resized or cut and in the statement that a substrate may include layers of similar or “different” materials. Ex. 1001 at 1:65-66, 3:53-55; EX1002, Application at [0007], [0025]. Those passages concern qualitative differences between materials and

differences in material composition, not a directionally neutral dimensional relationship.

81. In my opinion, a POSITA would understand “different” in Claims 1 and 13 to be broader than “smaller.” A substrate that is one-sixteenth inch smaller than a porcelain sheet and a substrate that is one-sixteenth inch larger than that sheet are both dimensionally “different” from it. The specification, however, discloses only the smaller of those two configurations. The claims therefore encompass a broader class of dimensional relationships than the class the inventor described.

82. I have also considered the specification’s statement that a substrate sheet may be “sized and dimensions approximately similarly” to the porcelain sheet. Ex. 1001 at 3:38-39. In my opinion, that single, qualified statement does not convey possession of a substrate sheet that is affirmatively larger than the porcelain sheet. Nor does it describe the claimed directionally neutral genus of substrates that may differ from the porcelain sheet in either direction. The remainder of the sizing disclosure repeatedly describes a smaller substrate and an inset of the substrate edges from the porcelain edges. *Id.* at 3:38-48, FIG. 1.

83. The functional discussion in the specification further confirms my opinion. The specification does not merely treat a smaller substrate sheet as an example within a broader class of differently sized substrate sheets. Instead, it affirmatively explains that “[t]he inset of the sheet of substrate” may “facilitate better

sealing during installation of adjacent sheets of porcelain.” Ex. 1001 at 3:39-48. The specification explains that this inset configuration would yield a “relatively larger gap . . . between adjacent sheet of substrate,” allowing more sealant to be inserted into the fill joints along the length and width of the adjacent porcelain sheets, which “may enable a better, more resilient seal” and “a more finished appearance between adjacent construction panels.” *See id.* at 5:34-48. In my opinion, these descriptions of the smaller, inset-substrate configuration and its functional benefits would indicate to a POSITA that the inventor possessed that specific configuration, not a broader class encompassing substrate sheets that are larger than the porcelain sheet.

84. The prosecution history is consistent with that conclusion. In April 2024, the Applicant amended then-pending Claim 14, which issued as Claim 13, to recite a substrate “between about one-sixteenth of an inch and one-eighth of an inch smaller in length and width than the porcelain sheet.” EX1002, Applicant’s April 16, 2024 Amendment and Arguments at 1-2. In July 2024, the Applicant similarly amended then-pending Claim 8, which issued as Claim 1, to recite a substrate “between zero and an eighth of an inch smaller in length and width than the porcelain sheet” and amended then-pending Claim 14, which issued as Claim 13, to recite a substrate “up to an eighth of an inch smaller.” EX1002, Applicant’s July 19, 2024 Amendment and Arguments at 1. The claims therefore used the directional term “smaller” for more than a year of prosecution.

85. The Applicant did not replace “smaller” with “different” until the March 18, 2025 amendment. EX1002, Applicant’s March 18, 2025 Amended Claims at 1-2. That amendment changed then-pending Claim 8, which issued as Claim 1, from “between zero and an eighth of an inch smaller” to “between zero and an eighth of an inch different,” and similarly introduced “different” into then-pending Claim 14, which issued as Claim 13. In my opinion, replacing “smaller” with “different” broadened the dimensional limitation to include configurations not described in the specification.

86. The Applicant’s accompanying prosecution statements did not identify support for that broader scope. Although the amended claims used “different,” the Applicant continued to describe them as requiring the substrate sheet or foam board to be “up to an eighth of an inch smaller in length and width than the porcelain sheet.” EX1002, Applicant’s March 18, 2025 Remarks at 1. Earlier, the Applicant had likewise relied on the smaller-substrate configuration to distinguish the prior art and had cited Figure 5 and the associated disclosure as showing construction panels “with the substrate sheet smaller in length than the porcelain sheet.” EX1002, Applicant’s April 16, 2024 Remarks at 1-2; Appeal Brief at 10-11. I found no prosecution statement in which the Applicant asserted that the originally filed disclosure described a substrate larger than the porcelain sheet.

87. When introducing “different,” the Applicant cited Figure 2 and the paragraph concerning the substrate’s lightweight structure as support. EX1002, Applicant’s March 18, 2025 Amendment and Arguments at 1. That cited paragraph addresses substrate materials, including types of foam and foam board, rather than the relative dimensions of the substrate and porcelain sheets. The Applicant did not cite the sizing-specific passages, which describe approximately similarly sized or smaller substrates and an inset configuration. In my opinion, the cited disclosure would not convey to a POSITA that the inventor possessed a substrate larger than the porcelain sheet.

88. I also understand that the Examiner’s earlier treatment of the sizing limitation recognized the narrow nature of the specification’s dimensional disclosure. In the May 16, 2024 First Final Rejection, the Examiner rejected then-pending Claims 14-21, which issued as Claims 13-20, and then-pending Claim 22, which issued as Claim 7, under § 112(a), finding that the specification “only provides support for 1/16th of an inch, not necessarily 1/8th of an inch.” EX1002, First Final Rejection dated May 16, 2024 at 3-4. Although that rejection addressed the magnitude rather than the direction of the size difference, it confirms that the Examiner viewed the disclosed dimensional support as tied to the specific smaller-substrate example in the specification.

89. I understand that the Examiner later entered the amendment that replaced “smaller” with “different” and stated that no new matter had been added, but did not analyze whether the broadened term had written-description support. EX1002, Second Final Rejection dated July 1, 2025 at 2. The Notice of Allowance stated only that the prior art did not expressly disclose the claimed size difference together with the limitation concerning the substrate’s side surface. *Id.*, Notice of Allowance dated August 19, 2025 at 2-3. I found no indication that the Examiner considered whether the originally filed disclosure conveyed possession of a substrate larger than the porcelain sheet.

90. In my opinion, Claim 13 demonstrates the conflict between the disclosure and the broadened term. Its selecting step recites a foam board “up to an eighth of an inch different in length and width than the porcelain sheet,” while a later limitation requires that “the foam board is up to an eighth of an inch smaller in length and width than the porcelain sheet.” Ex. 1001 at Claim 13. Only the “smaller” relationship is described in the specification. In my opinion, the use of both terms in Claim 13 further confirms that “different” introduced scope beyond the smaller configuration disclosed in the originally filed application.

91. In my opinion, the additional limitations of the dependent claims do not resolve this issue. Claims 2-10 depend from Claim 1, and Claims 14-20 depend from Claim 13. Ex. 1001 at Claims 2-10, 14-20. Each therefore incorporates the

unsupported directionally neutral “different” limitation. None of the additional dependent-claim limitations supplies a description of a substrate sheet or foam board larger than the porcelain sheet.

92. Based on my review of the claims, the specification, the provisional and non-provisional applications, and the prosecution history, it is my opinion that the specification conveys possession of substrate sheets that are approximately similarly sized or smaller than the porcelain sheet, with the detailed embodiments and identified functional benefits directed to a smaller, inset substrate. It does not convey possession of the broader class introduced during prosecution by replacing “smaller” with “different,” which encompasses a substrate sheet or foam board larger than the porcelain sheet. Accordingly, it is my opinion that Claims 1-10 and 13-20 lack adequate written-description support under 35 U.S.C. § 112(a).

ii. Claim 10 also cites a “cure time” range that lacks adequate written description.

93. Apart from being dependent on claim 1, which lacks written description for the reasons set forth above, claim 10 is invalid because the originally filed application fails to provide support for the later added limitation that “a cure time is between about zero and about 10 minutes.” The original application disclosed only a cure time range of “between about zero and 24 hours” and nowhere described, suggested, exemplified, or identified a cure time range ending at 10 minutes. As a result, the specification does not reasonably convey to a person of ordinary skill in

the art that the inventors possessed the later claimed 0 to 10-minute cure time range as of the filing date.

94. Here, the originally filed application disclosed only a cure time range of “between about zero and 24 hours.” The application did not disclose a cure time range ending at 10 minutes, did not identify 10 minutes as an endpoint, did not provide examples employing cure times of 10 minutes or less, did not identify rapid curing as a preferred embodiment, and did not otherwise suggest that a cure time limited to 10 minutes constituted any aspect of the invention.

95. The added claim isolates an extremely small subset of the originally disclosed range. A cure time of 10 minutes is dramatically shorter than the disclosed upper endpoint of 24 hours. Yet the specification provides no indication that this narrow subrange was contemplated, preferred, or even recognized by the inventors. The claim therefore does not merely select a disclosed range. It introduces a previously undisclosed upper endpoint and a previously undisclosed subrange.

96. Here, nothing in the specification directs a skilled artisan to that range or suggests that cure times of 10 minutes or less formed part of the invention described by the applicants. The 151 Patent does not disclose a specific adhesive material that can achieve a given mechanical strength in the stipulated time. For example, an epoxy can react and develop some initial strength for handling, then continue to react over time to fully crosslink and achieve maximum strength. A

physical property measurement like hardness testing measurement as a function of time is often used to determine if the adhesive had developed the required properties. As a result, my opinion is that Gust did not have possession of the specific recited range.

iii. Claims 11 and 12 lack written description support because it omits steps required in all embodiments and includes others that are never described.

97. Claim 11 uses the closed transitional phrase “consisting of,” which limits the method to *only* the enumerated steps. Yet every embodiment in the specification describes applying a compressive force (e.g., via a roller at 30–40 psi) as an integral part of the joining process. Indeed, the specification’s entire detailed discussion of “joining” is described *through* the application of compressive force—FIG. 4 and the accompanying text describe the compression element being moved across the substrate to achieve a “tight bond.” The specification never describes joining the porcelain and substrate *without* applying compressive force. A POSITA reading this specification would not understand the inventor to have been in possession of a method that affirmatively excludes compression from the joining process.

98. Claim 11 recites two discrete “selecting” steps—“selecting a porcelain sheet” and “selecting a foam board.” The specification never describes, or even uses the word, “selecting” as a method step. There is no disclosure of a discrete act of

choosing or selecting particular sheets of porcelain or foam board as part of the claimed method, nor any description of criteria or parameters by which such a selection would occur. A POSITA would not understand the specification to disclose a method step of selecting a porcelain sheet or a substrate sheet.

C. Ground 3: Claims 1-12 Are Invalid Under 35 U.S.C. § 102 as Being Anticipated by Caselli.

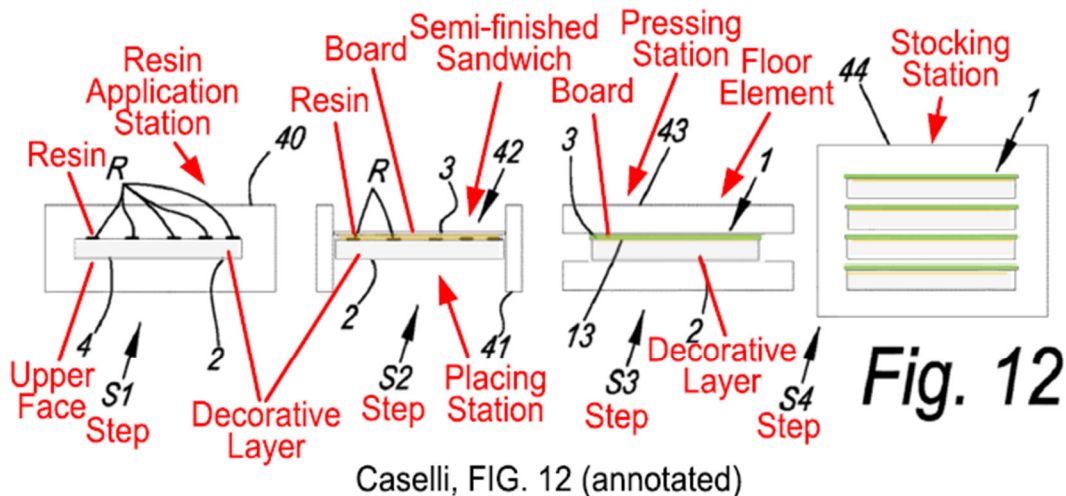
99. In my opinion, a POSITA would understand Caselli to disclose all limitations of independent Claim 1.

i. Claim 1 is anticipated by Caselli.

a. Preamble: “A method of joining a substrate sheet to a porcelain sheet with adhesive, the porcelain sheet having a finished side and a back side, the method comprising:”

100. To the extent the preamble is limiting, Caselli discloses “a method for manufacturing a floor element comprising the steps of: providing a decorative layer made of a ceramic material; providing a board; providing a resin material for bonding the decorative layer and the board together; pressing the layers together for forming the floor element such that the resin material permeates the ceramic layer.” EX1004 at 20:48-55. Caselli also discloses that “the ceramic tile is made of porcelain” (*id.* at 11:4-6), “[t]he decorative layer has an upper face comprising a décor” (*id.* at 12:1-2) and a “lower[,] . . . non-visible surface (in use) that is opposite to the upper decorative surface” (*id.* at 11:38-40), and “an intermediate layer [is] disposed between the decorative layer and the board[, t]he intermediate layer

preferably compris[ing] an adhesive or a resin that bonds together the decorative layer and the board” (*id.* at 14:33-37). Caselli’s Figure 12 shows the entire method of manufacturing in detail.



101. Caselli discloses a method of joining a board (i.e., the 151 Patent’s “substrate sheet”) to a porcelain decorative layer (i.e., the 151 Patent’s “porcelain sheet”) using adhesive. The porcelain tile has an upper decorative face (i.e., the 151 Patent’s “finished side”) and a lower surface (i.e., the 151 Patent’s “back side”). Caselli’s adhesive/resin functions to bond its decorative layer and board together.

b. 1[a]: “applying a surface of the porcelain sheet back side with adhesive;”

102. In my opinion, a POSITA would understand Caselli to disclose Limitation 1[a].

103. Caselli discloses “the step of providing the [adhesive/]resin comprises the step of applying a non-cured [adhesive/]resin on at least a surface of the decorative layer and/or of the board” (EX1004 at 21:55-57), with “the uncured resin material [being] provided . . . onto a lower surface of the decorative layer” (*id.* at 32:56-58). Caselli also discloses that “the [adhesive/]resin is in a substantially liquid state during the manufacturing process of the floor element.” *Id.* at 16:7-9. A POSITA would immediately think of “spray coating” (which is consistent with the description in Gust) in connection with the application of the liquid adhesive.

104. Caselli discloses applying uncured resin (i.e., the 151 Patent’s “adhesive”) onto the lower surface (i.e., the 151 Patent’s “back side”) of the porcelain decorative layer (i.e., the 151 Patent’s “porcelain sheet”) during the floor element manufacturing process.

c. Limitation 1[b]: “stacking the porcelain sheet and the substrate sheet so that the surface of the porcelain sheet back side faces a surface of the substrate sheet; and”

105. In my opinion, a POSITA would understand Caselli to disclose Limitation 1[b].

106. Caselli discloses a manufacturing step (“S2”) in which its “decorative layer 2 is carried into a placing station 41 wherein the board 3 is provided,” and the board “is placed below the lower surface [of the] decorative layer 2 thereby forming a semi-finished sandwich[,] [p]referably [with] . . . the decorative layer 2 and the

board 3 properly centered each other.” EX1004 at 32:64 – 33:2. Caselli also specifies that “the intermediate layer 15 is in direct contact with the upper surface of the board 3 so that” the intermediate layer will “act as a glue between the decorative layer 2 and the board 3.” EX1004 at 28:36-39.

107. As I understand Claim 1, “stacking” is satisfied when the two sheets are placed next to one another with the porcelain back side directed toward a surface of the substrate, so that those surfaces can be brought together for bonding.

108. Caselli discloses stacking the porcelain decorative layer and the board so that the lower surface (i.e., the 151 Patent’s “back side”) of the porcelain decorative layer (i.e., the 151 Patent’s “porcelain sheet”) faces the upper surface of the board (i.e., the 151 Patent’s “substrate sheet”), forming a sandwich structure. Caselli’s decorative layer and board are properly centered (i.e., “stacked”) on each other, with the adhesive/resin intermediate layer in direct contact between the back side of the decorative layer and the board surface.

d. Limitation 1[c]: “joining the surface of the porcelain sheet back side to the surface of the substrate sheet,”

109. In my opinion, a POSITA would understand Caselli to disclose Limitation 1[c].

110. Caselli discloses a manufacturing step (“S3”) in which “the semi-finished sandwich 42 is carried into a pressing station 43 wherein the layers 2,3 are pressed together for forming the floor element 1 such that the [adhesive/]resin

material permeates the pores of the ceramic material of the decorative layer 2 and forms the intermediate layer 15.” EX1004 at 33:3-7. Caselli explains that “the intermediate layer acts as an adhesive layer that bonds together the decorative layer and the board.” EX1004 at 17:40-41.

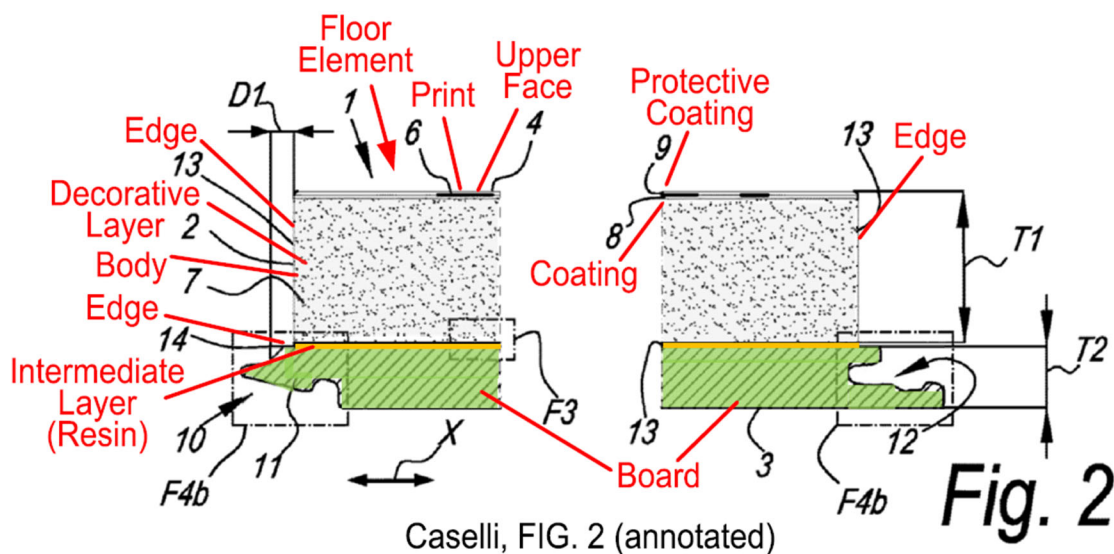
111. Caselli discloses pressing the porcelain decorative layer and the board together so the resin permeates the ceramic material and bonds the layers, thereby joining the back side of the porcelain to the surface of the board.

e. Limitation 1[d]: “wherein the substrate sheet is between zero and an eighth of an inch different in length and width than the porcelain sheet, and”

112. In my opinion, a POSITA would understand Caselli to disclose Limitation 1[d]. As I opined above, I do not believe the application as filed supports any reading that this claim covers substrates that are larger than the porcelain sheets to which the substrate is joined. However, if it is found that claim 1 can encompass such arrangements, then Caselli clearly discloses this limitation.

113. Caselli discloses that “the board has a shape basically corresponding to the decorative layer, however, preferably, with one or more portions extending beyond the decorative layer.” EX1004 at 13:48-50. Caselli later explains an example of this configuration (shown in FIG. 2, reproduced below)—with “[t]he board 3 extend[ing] beyond longitudinal edges 13 of the decorative layer 2”—in which “the board 3 comprises upper longitudinal edges 14 that extend beyond the longitudinal

edge 13 of the decorative layer 2 of a distance DI[,] . . . equal on both the opposite longitudinal edges 13 of the decorative layer 2.” EX1004 at 28:4-9, FIG. 2. Caselli also discloses “grout 29 filling an intermediate distance I separating the decorative layers” (*id.* at 30:45-46), that this “intermediate distance I is twice the distance DI” (*id.* at 30:47-49), and that “an intermediate distance of at least 1.5 millimeter, for example around 3 millimeters or more is preferred” (*id.* at 14:8-10).



114. These disclosures satisfy the claim limitation requiring “the substrate sheet is between zero and an eighth of an inch different in length and width than the porcelain sheet.” Because the intermediate distance I equals twice DI, and Caselli discloses I as “at least 1.5 millimeter, for example around 3 millimeters,” DI equals 0.75 mm to approximately 1.5 mm per side. The board (substrate sheet) thus extends beyond the decorative layer (porcelain sheet) by approximately 1.5 mm to 3 mm in

each of length and width ($2 \times \text{DI}$ per dimension). One-eighth of an inch is approximately 3.175 mm. If the limitation is construed as requiring the difference in length and the difference in width each to independently fall between zero and one-eighth of an inch, it is met at either end of Caselli's disclosed range—whether the board extends beyond the decorative layer by approximately 1.5 mm or 3 mm per dimension, both values fall below 3.175 mm. If instead the limitation is thought to require the combined difference in length and width to fall between zero and one-eighth of an inch, it is met when the board extends beyond the decorative layer by approximately 1.5 mm per dimension, yielding a combined difference of approximately 3 mm—still below 3.175 mm.

f. Limitation 1[e]: “wherein the porcelain sheet does not adhere to a side surface of the substrate.”

115. In my opinion, a POSITA would understand Caselli to disclose Limitation 1[e].

116. Caselli discloses mounting its decorative layer (porcelain sheet) centered on top of the board (substrate) such that, in the coupled condition, “said intermediate distance is available between the edges of adjacent decorative layers, while the edges of the underlying board are coupled to each other by means of the available coupling elements.” EX1004 at 13:63 – 14:2. As shown in Figure 2 (above), the board's upper longitudinal edges (14) extend beyond the decorative layer's longitudinal edges (13) by a distance DI. *Id.* at 28:5-7. Because the decorative

layer terminates inward of the board's peripheral edges, the decorative layer is positioned entirely on the board's upper surface and does not extend onto, overlap, or contact any side surface of the board.

117. Caselli further discloses that the adhesive bonds only the mating horizontal surfaces: “the uncured [adhesive/]resin material R is provided ... onto a lower surface of the decorative layer” (*id.* at 32:56–58), and that the adhesive/resin covers “at least a portion of the lower surface of the decorative layer ... for example ... 100 percent of the lower surface of the decorative layer.” *Id.* at 17:16-22. As shown above in Figure 2, the adhesive-containing intermediate layer (15) is disposed between the lower surface of decorative layer (2) and the upper surface of board (3), while the board side surfaces remain exposed. Caselli never discloses or depicts applying adhesive or fixing a decorative sheet to any side edge of the board.

118. Because the decorative layer (porcelain sheet) is confined to the board's (substrate) upper surface and terminates inward of the board's side surfaces, the decorative layer does not contact the board's side surfaces. Further, because Caselli teaches mounting its decorative layer on its board so that “the edges of the underlying board are coupled to each other by means of the available coupling elements,” these coupled edges of the underlying board are covered by coupling elements and not free to be adhered to a decorative layer. Moreover, because Caselli discloses applying adhesive only between the decorative layer's (porcelain sheet)

lower surface and the board's (substrate) upper surface, the decorative layer likewise is not adhered to any side surface of the board.

119. Accordingly, in my opinion, a POSITA would understand Caselli to disclose every limitation of Claim 1.

ii. Claim 2 is anticipated by Caselli.

a. “The method of claim 1, wherein the adhesive is waterproof”

120. In my opinion, a POSITA would understand Caselli to disclose the additional limitation of Claim 2.

121. Caselli discloses that the adhesive bonding the porcelain decorative layer to the board is preferably an epoxy resin—a waterproof adhesive well-known to a POSITA at the effective filing date. EX1004 at 15:16-17.

122. Caselli further discloses floor elements, substrate, and a floor covering that are waterproof. EX1004 at 5:5-8, 9:24, 20:34-36. A POSITA would understand that the epoxy resin adhesive disclosed in Caselli is waterproof, and Caselli's express emphasis on impermeability and waterproofness of the assembled product further supports that the adhesive itself is waterproof.

123. Accordingly, in my opinion, a POSITA would understand Caselli to disclose that the adhesive is waterproof. Because Paganelli discloses every limitation of Claim 1 and the additional limitation of Claim 2, Paganelli anticipates Claim 2 under 35 U.S.C. § 102.

iii. Claim 3 is anticipated by Caselli.

- a. “The method of claim 1, wherein joining the surface of the porcelain sheet back side to the surface of the substrate sheet includes applying a force across the entire substrate sheet.”**

124. Claim 3 depends from Claim 1 and adds the requirement that joining the porcelain sheet’s back-side surface to the substrate sheet’s surface “includes applying a force across the entire substrate sheet.” As explained above, in my opinion, a POSITA would understand Caselli to disclose every limitation of Claim 1.

125. In my opinion, a POSITA would also understand Caselli to disclose the additional limitation of Claim 3.

126. Caselli discloses “joining the surface of the porcelain sheet back side to the surface of the substrate sheet.” Caselli also discloses that “the step of pressing may be a static pressing step wherein the layers enters into a mold of a static press so that is subjected to a predetermined pressure by means of a punch of the press.” EX1004 at 22:52-55. Caselli further discloses that “during the pressing step it is exerted onto the layers a pressure of at least 350 kg/sqm, more preferably at least 370 kg/sqm” and that “said values have been found optimal to make the resin permeate the decorative layer [and] . . . for allowing the resin to reach a 100% coverage of the lower surface of the decorative layer.” *Id.* at 22:24-30. Caselli also discloses an alternative embodiment in which “the step of pressing may be a

lamination step wherein the layers runs into a laminating equipment, for example under one laminating roller or belt, or between a couple of laminating rollers, so that is subjected to a predetermined pressure.” *Id.* at 22:57-62.

127. Caselli’s static press applies a predetermined pressure via a punch onto the layered assembly—the decorative layer placed above the board—and the pressure values are defined per unit area (kg/sqm) and are expressly designed to achieve 100% resin coverage of the lower surface of the decorative layer. Because the function of the pressing step is to bond the decorative layer to the board, and because achieving full-surface resin permeation across the entire decorative layer requires pressing across the corresponding area of the board beneath it, a POSITA would have understood that Caselli’s static press applies force across the entire area of the substrate sheet (board).

128. Caselli’s alternative “lamination step” embodiment further confirms this understanding—as lamination rollers progressively apply force across the entire surface of the substrate as the layered assembly passes through.

129. This discloses applying a force across the entire substrate sheet.

130. Accordingly, because Caselli discloses every limitation of Claim 1 and discloses the additional force limitation of Claim 3, it is my opinion that Caselli anticipates Claim 3.

iv. Claim 4 is anticipated by Caselli

- a. “The method of claim 3, wherein the force applied across the entire substrate sheet is between about thirty pounds per square inch and about forty pounds per square inch.”**

131. Caselli discloses that exerting “a pressure of at least 350 kg/sqm, more preferably at least 370 kg/sqm” onto its board and decorative layers during its pressing step. EX1004 at 22:24-26. 350-370 kilograms per square meter is equivalent to about 0.5 psi.

132. Caselli’s disclosure of using a pressure of at least 0.5 psi during its pressing step includes a pressure between 30-40 psi because this range is greater than 370 kilograms per square meter. While application of pressure can improve contact between a porcelain sheet, adhesive, and substrate and may reduce bondline thickness, I am unaware of any generally accepted materials-science principle indicating that a pressure of specifically 30-40 psi would be critical for such purposes. Rather, the effectiveness of pressure depends on numerous factors including adhesive chemistry, viscosity, substrate characteristics, surface roughness, and desired bondline thickness. In my opinion, the 30-40 psi range is not described or supported in the 151 Patent, but it nevertheless is disclosed in Caselli.

133. Caselli also discloses that its “method for manufacturing a floor element comprising the step[] of . . . pressing the” “board” and “decorative layer” “together . . . such that the resin material permeates the ceramic layer.” EX1004 at

20:48-55. Compressing the board (substrate sheet) and decorative layer (porcelain sheet) so that the adhesive resin material permeates the ceramic decorative layer requires the application of compressive force across the entire board (and the decorative layer) to achieve permeation of the resin material into the decorative layer and proper adhesion of the board to the decorative layer.

v. Claim 5 is anticipated by Caselli

a. Claim 5: “The method of claim 3, wherein the compressive force is not applied during a cure time of the adhesive.”

134. Caselli describes that in “step S4 [the] pressed floor element 1 is then carried into a stocking station 44 wherein for a predetermined stocking time in order to allow the resin R to continue curing before being, packaged, transported and/or used in a floor covering. Preferably the stocking time is such to allow the resin R to be at least 70% cured, preferably 85% cured, more preferably fully cured. For example, said stocking time is at least 0.5 h, preferably more than 1 h, for example 2 h.” EX1004, 33:15-22 (emphasis added). Thus, Caselli describes removing the pressed floor element 1 from the pressing station 43 and placing it in the stocking station 44 “in order to allow the resin R to continue curing.” As a result, a POSITA would understand that the resin continues to cure after the floor element is no longer being compressed, resulting in the compressive force not being applied during a cure time of the adhesive.

vi. Claim 6 is anticipated by Caselli

- a. “The method of claim 1, wherein a cure time after joining the porcelain sheet back side to the surface of the substrate sheet is between about zero and about 24 hours.”**

135. Caselli expressly discloses a cure time (the “stocking time”) of “at least 0.5 [hours], preferably 1 [hour], for example 2 [hours]” (EX1004 at 23:3-10, 33:15-22)—all of which fall squarely within the claimed range of “between about zero and about 24 hours.” Caselli’s discloses this stocking/cure time as “step S4” of its “method for manufacturing a floor element.” *Id.* at 32:52 – 33:19. “[S]tep S4” occurs after “step S2”—in which “[t]he board 2 is placed below the lower surface decorative layer 3” (i.e., the board (substrate sheet) is joined with the decorative layer (porcelain sheet)—is completed in this method. *Id.*

vii. Claim 7 is anticipated by Caselli

- a. “The method of claim 1, wherein the substrate sheet is lightweight relative to the porcelain sheet.”**

136. A POSITA would have understood from Caselli’s disclosure that the polymeric board is “lightweight relative to the porcelain sheet.”

137. Caselli discloses that the board is preferably made of polymeric material— “[p]referably . . . made of a thermoplastic polymeric material, . . . [such as] PVC (polyvinyl chloride)[,] polyurethane, . . . , polyethylene, polypropylene, [or] polyethylene terephthalate,” and preferably includes a “filler material[,], such as chalk,” with the content of the filler preferably below 60%, more preferably below

50%, of the weight percentage of the board—that is “low weight” relative to the heavy porcelain/ceramic decorative layer (*see* EX1004 at 8:4-15, 8:43-51). Caselli discloses that the board has preferably a thickness between 3.2 and 6 mm, more preferably about 4 mm (*id.* at 9:11-12), while the decorative layer has a thickness “comprised between 4 and 15 mm, for example above 6 mm, preferably above 7 mm, for example about 8 or about 10 mm” (*id.* at 12:42-44). The board is therefore thinner than the decorative layer in every more-preferred embodiment.

138. The board is also less dense than the porcelain decorative layer. Porcelain stoneware tile has a well-established density of approximately 2.38-2.45 g/cm³. *See* García-Ten et al., *Development of lightweight porcelain stoneware tiles using foaming agents*, J. Eur. Ceram. Soc., Vol. 32, pp. 745-752 (2012) (reporting that “[p]orcelain stoneware tiles are characterised by their high density (2380-2450 kg/m³)”); *see also* Environmental Product Declaration EPD-IES-0006762 (S-P-06762) for Porcelain Tile (disclosing the same range).

139. By contrast, the densities of the thermoplastic polymers Caselli discloses for the board are far lower.

140. Standard engineering references report the following densities: PVC—approximately 1.38 g/cm³; polyethylene (HDPE)—approximately 0.95-0.96 g/cm³; polypropylene—approximately 0.90-0.91 g/cm³; PET—approximately 1.30-1.40 g/cm³; and polyurethane—approximately 1.05 g/cm³. *See* AmesWeb, *Density of*

Plastics and Polymers, (citing Oberg et al., *Machinery's Handbook* (30th ed., Industrial Press Inc., 2016); Callister, *Materials Science and Engineering: An Introduction* (7th ed., Wiley, 2007)), <https://www.amesweb.info/Materials/Density-of-Plastics.aspx> (last visited September 6, 2026) (listing densities for common thermoplastics, including PVC at 1.384 g/cm³, HDPE at 0.959 g/cm³, PP at 0.905 g/cm³, PET at 1.34 g/cm³, and polyurethane at 1.052 g/cm³); *see also* SpecialChem, Density of Plastics (reporting PET at 1.30-1.40 g/cm³, HDPE at 0.94-0.97 g/cm³, and PP at 0.90-0.91 g/cm³).

141. Even the densest disclosed polymer (PVC, ~1.38 g/cm³) is approximately 42% less dense than porcelain (~2.4 g/cm³), and the lightest disclosed polymers (polyethylene, polypropylene) have densities 60% or more below porcelain.

142. It follows, then, that Caselli itself describes the polymeric board materials as having “relatively low weight.” *Id.* at 8:4-15.

viii. Claim 8 is anticipated by Caselli

a. “The method of claim 1, wherein the substrate is lightweight foam board relative to the porcelain sheet.”

143. Caselli’s polymeric board (substrate) is lightweight compared to its porcelain decorative layer (porcelain sheet). Additionally, Caselli discloses that the board is made of a compressible thermoplastic polymeric material (e.g., “PVC (polyvinyl chloride),” “polyurethane,” “polyethylene, polypropylene, [or]

polyethylene terephthalate”) that “leads to a board which is easily compressed at room temperature” (EX1004 at 8:9-18) and that this compressibility “allows for a certain adaptation to unevenness of the subfloor” (*id.* at 8:23-25). A POSITA would understand that the disclosure encompasses foam sheets or foam boards made from each of these materials, because all are known in the art as materials that can be produced in foamed forms. Each of the specific polymers Caselli identifies is well known in the art as a base resin for producing foam boards. However, I note that while polyurethane is identified as a thermoplastic polymeric material, many commercially available polyurethane foam boards are thermoset materials, such that this characterization may depend on the specific polyurethane formulation being considered.

ix. Claim 9 is anticipated by Caselli

- a. “The method of claim 1, wherein the stacking the substrate sheet and the porcelain sheet adjacently includes stacking the substrate sheet and the porcelain sheet horizontally.”**

144. Caselli discloses placing the decorative (porcelain) layer face-down in a horizontal orientation and then placing the substrate board on top of the porcelain layer’s back surface, such that the board back surface and the porcelain back side are stacked adjacently in a horizontal orientation before being pressed together. EX1004 at 32:61–67. A POSITA would understand this horizontal stacking process

to directly teach “stacking the substrate sheet and the porcelain sheet horizontally” as recited in claim 9.

x. Claim 10 is anticipated by Caselli

- a. “The method of claim 1, wherein a cure time after joining the porcelain sheet back side to the surface of the substrate sheet is between about zero and about 10 minutes.”**

145. As I explained above, I do not believe that the 151 Patent provides written description support for this claimed range. However, if the Board finds there to be sufficient support, then Caselli gives comparable or even greater disclosure to satisfy this element. A POSITA would have understood that at least one of these fast-curing resins, e.g., hot melt thermoplastic resin (*see* EX1004 at 14:42), is characterized by extremely rapid setting and bond formation upon cooling, typically developing their bond within about ten minutes of joining the substrates.

146. Thus, when practicing Caselli’s hotmelt thermoplastic resin embodiment, the bond formed between the porcelain tile and reinforcing element would likely achieve a cure time within the claimed range of “between about zero and about 10 minutes.”

xi. Claim 11 is anticipated by Caselli

- i. “11[pre]: “A method of creating a surface covering, the method consisting of:”**

147. Caselli discloses the preamble by expressly disclosing a method of manufacturing a floor element for forming a floor covering, which is a “surface covering” as recited in the preamble. *See* EX1004 at 1:1-4.

ii. “11[a]: “selecting a porcelain sheet with a porcelain back side:”

148. Caselli discloses selecting a decorative layer that is a porcelain tile (a porcelain sheet) (EX1004 at 11:4-6) with a lower surface (a porcelain back side) onto which the resin is applied (*id.* at 28:41-44).

iii. “11[b]: “selecting a foam board having a board back surface and board side surfaces:”

149. Caselli discloses providing a foam board. The board has an upper surface (board back surface) facing the decorative layer (*see* EX1004 at 28:36-39) and longitudinal and transversal edges (board side surfaces) (EX1004 at 27:55-58).

iv. “11[c]: “applying an adhesive to the porcelain back side:”

150. Caselli discloses “step s1” which includes applying an uncured resin (adhesive) onto the lower surface (porcelain back side) of the porcelain decorative layer at a resin application station. EX1004 at 32:54-58.

v. “11[d]: “stacking the porcelain sheet and the foam board so the porcelain back side faces the board back surface; and”

151. Caselli discloses a stacking step (“step S2”) in which the board is placed below the lower surface of the porcelain decorative layer to form a “semi-finished

sandwich,” such that the porcelain back side faces the board’s upper (back) surface. EX1004 at 32:59-67.

vi. “11[e]: “joining the porcelain back side to the board back surface,”

152. Caselli discloses—in its “step s3”—pressing the layers together so the resin bonds the porcelain decorative layer’s lower surface (porcelain back side) to the board’s upper surface (board back surface), thereby joining them. EX1004 at 33:3-7.

vii. “11[f]: “wherein the porcelain sheet does not contact the board side surfaces.”

153. Caselli discloses that its porcelain decorative layer “does not contact the board side surfaces” because of the differing lengths and widths of its decorative layer and board, its board’s side surfaces are manufactured for coupling with other board side surfaces, and its adhesive is only applied between its board and decorative layer. *See supra* Section VI.C.i (discussing limitation 1[e])

xii. Claim 12 is anticipated by Caselli

a. “The method of claim 11, wherein joining the porcelain sheet to the foam board includes applying compressive force across both the porcelain sheet and the foam board to adhere the foam board to the porcelain sheet.”

154. Caselli discloses pressing the stacked layers together (step S3) using a static press or lamination equipment. EX1004 at 22:51-62, 33:2-7; *see also supra*

Section VI.C.i (discussing limitation 1[c]). This compressive force is applied across both the porcelain decorative layer and the board back surface to cause the adhesive/resin to permeate the ceramic (porcelain) and bond the layers together, thereby adhering the board to the porcelain sheet. *Id.* at 33:2-7. Caselli’s “step s3” thus satisfies Claim 12’s limitation.

D. Ground 4: Claims 1-20 Are Invalid Under 35 U.S.C. § 102 as Being Anticipated by Paganelli

i. Claim 1 is anticipated by Paganelli.

a. Preamble: “A method of joining a substrate sheet to a porcelain sheet with adhesive, the porcelain sheet having a finished side and a back side, the method comprising:”

155. Paganelli discloses a covering element comprising a porcelain tile joined with a reinforcing element / substrate. EX1005 at 1:56-58, 2:41-42. Paganelli also discloses the claimed substrate sheet and the step of joining that substrate sheet to the porcelain sheet with adhesive. *Id.* at 12:3-4.

156. Paganelli also discloses that the porcelain tile has Claim 1’s “finished side and a back side.” *Id.* at 2:48-61. Paganelli also teaches fixing or gluing a reinforcing element to that “lower surface of the tile.” *Id.* at 4:4-8, 12:3-4. Paganelli’s decorative upper surface corresponds to the claimed finished side and that Paganelli’s lower surface corresponds to the claimed back side.

157. Paganelli incorporates by reference the “method for [creating] reinforc[ed] ceramic tiles” (EX1005 at 1:37-38) “described in the international

application WO 2010/072704” (EX1005 at 4:53-55, 12:46-48), a single-method PCT application devoted entirely to the process of bonding a tile to a support plate—and thus is identifiable by a POSITA as part of the reference.

b. Limitation 1[a]: “applying a surface of the porcelain sheet back side with adhesive;”

158. Paganelli discloses applying adhesive to a surface of the back side of the porcelain sheet. Paganelli discloses that “[p]referably, the reinforcing element is associated with, for example fixed, or preferably glued, to the lower surface of the tile,” and that “[p]referably, the reinforcing element is fixed to the lower face of the tile by means of an adhesive.” EX1005 at 12:3-4. As explained above, Paganelli’s porcelain tile is the claimed porcelain sheet, and its “lower surface” or “lower face” is the sheet’s back side.

c. Limitation 1[b]: “stacking the porcelain sheet and the substrate sheet so that the surface of the porcelain sheet back side faces a surface of the substrate sheet; and”

159. The 151 Patent uses “stacking” broadly to encompass positioning the porcelain and substrate sheets adjacent to each other for adhesion. This adjacent, facing relationship is the only orientation of the sheets that Claim 1 requires; it does not require the sheets to be vertical, horizontal, or otherwise oriented relative to any external frame of reference. EX1001 at 4:28-48.

160. The specification explains: FIG. 3 illustrates a sheet of substrate **310** located adjacent to a sheet of porcelain **300** for adhesion, such as in a stacking relationship. After the application of adhesive (e.g., as illustrated in FIG. 2), the sheet of porcelain **300** and the sheet of substrate **310** may be positioned adjacent to each other. The sheet of substrate **310** and the sheet of porcelain **300** may be moved into contact with one another (e.g., as indicated by the arrows in FIG. 3). A surface of the sheet of substrate **310** may be moved into contact with a back side (e.g., unfinished side **202**) of the sheet of porcelain **300**. Substrate **310** may be waterproof (e.g., having a resistance to degradation caused by water). *FIG. 3 illustrates the sheets of material positioned or stacked substantially vertically though this need not be the case. The sheet of porcelain 300 may be positioned horizontally with the surface having adhesive facing upward*, and the sheet of substrate **310** may be positioned horizontally with the surface having adhesive facing downward (e.g., as illustrated in FIG. 4) when the sheets are moved into contact. *Other configurations are contemplated by this disclosure.* EX1001 at 4:28-48 (emphasis added).

161. Paganelli discloses this arrangement. Paganelli's porcelain tile is the claimed porcelain sheet, its reinforcing element is the claimed substrate sheet, and the tile's "lower surface" or "lower face" is its back side. Paganelli discloses that "the reinforcing element is associated with, for example fixed, or preferably glued,

to the lower surface of the tile” and that “the reinforcing element is fixed to the lower face of the tile by means of an adhesive.” EX1005 at 12:3-4. To be fixed or glued in that manner, the reinforcing element and tile necessarily must be positioned adjacent to one another with a surface of the reinforcing element facing the tile’s lower, back-side surface. The two facing surfaces are then brought together so that the reinforcing element can be adhesively fixed to the tile.

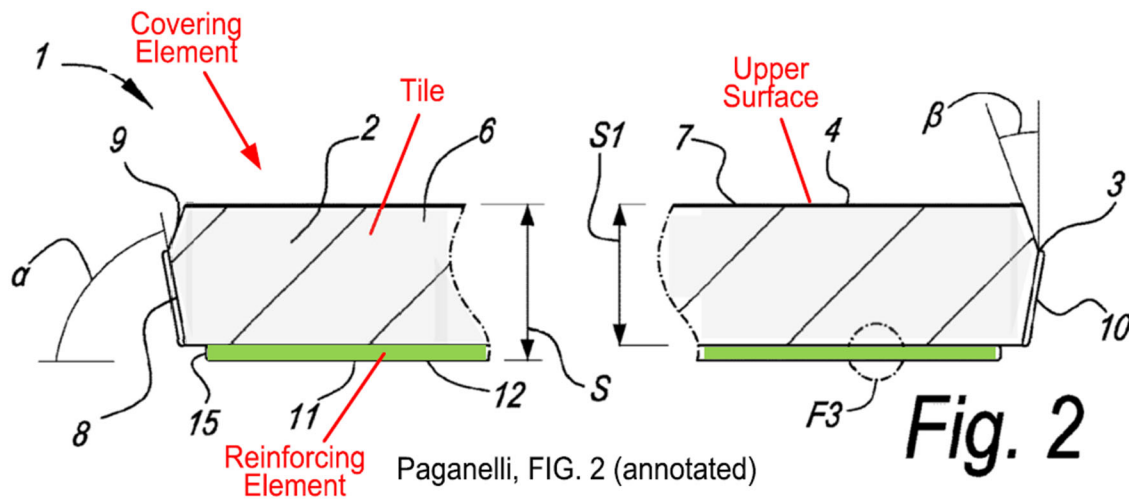
d. Limitation 1[c]: “joining the surface of the porcelain sheet back side to the surface of the substrate sheet,”

162. Paganelli expressly discloses joining the surface of the porcelain sheet’s back side to a surface of the substrate sheet. Paganelli describes its covering element as comprising “a tile of ceramic material and a reinforcing element joined to the tile.” EX1005 at 1:56-58. More specifically, Paganelli teaches that the reinforcing element is “fixed, or preferably glued, to the lower surface of the tile” and “fixed to the lower face of the tile by means of an adhesive.” *Id.* at 4:6-10. By fixing a surface of the reinforcing element to the tile’s lower surface with adhesive, Paganelli joins the surface of the porcelain sheet’s back side to the surface of the substrate sheet.

e. Limitation 1[d]: “wherein the substrate sheet is between zero and an eighth of an inch different in length and width than the porcelain sheet, and

163. Paganelli discloses a reinforcing element whose length and width are different from those of the porcelain tile. In describing its Figure 2 (annotated

below), Paganelli discloses that “the reinforcing element **11** has a slightly smaller horizontal size (in plan view) than that of the lower surface **12** of the tile **2**.” EX1005 at 12:9-11. Paganelli further discloses that the reinforcing element’s “edges **15** . . . do not project beyond the edges **3** of the tile **2**” and instead “are contained within the perimeter defined by the edges **3** of the tile **2**.” *Id.* at 12:11-16. Thus, Paganelli discloses that the reinforcing element is shorter in length and width than the tile. Paganelli’s Figures 6 and 9-13 (annotated Fig. 13 shown below) are consistent with that disclosure, depicting an inset of reinforcing element **11** relative to tile **2**.



of the reinforcing element—not between the tile and a side surface of the reinforcing element.

166. Paganelli further explains that the reinforcing element has “a slightly smaller horizontal size (in plan view)” than the tile, that its edges **15** “do not project beyond the edges **3** of the tile **2**,” and that those edges “are contained within the perimeter defined by the edges **3** of the tile **2**.” *Id.* at 12:9-16. Paganelli’s Figures 6 and 9-13 (above) likewise depict the reinforcing element inset from the tile’s perimeter, with the tile supported on the reinforcing element’s upper-facing surface and the reinforcing element’s side surfaces terminating inward of the tile’s edges. In this arrangement, the tile overlies and adheres to the opposing surface of the reinforcing element but does not wrap around or adhere to any side surface of that element.

ii. Claim 2 is anticipated by Paganelli.

a. “The method of claim 1, wherein the adhesive is waterproof.”

167. Paganelli discloses the use of a waterproof adhesive to join the reinforcing element to the porcelain tile. Paganelli teaches that “the reinforcing element is fixed to the lower face of the tile by means of an adhesive, preferably a thermosetting resin, for example an epoxy, polyurethane, acrylic and/or hotmelt glue.” EX1005 at 12:3-6. Thus, Paganelli expressly identifies epoxy and polyurethane as a preferred adhesives in forming the claimed adhesion between

Paganelli's tile and reinforcing sheet. A POSITA would have understood that the disclosed thermosetting epoxy or polyurethane adhesive, when used as Paganelli directs, necessarily forms a waterproof bond that maintains adhesion in the presence of water.

168. Paganelli's disclosed operating environment confirms the water-resistant character of that adhesive bond. Paganelli teaches providing the reinforcing metal sheet with protective coverings to protect it from corrosion, thereby making "the covering element" suitable "for use outside and/or in wet environments." *Id.* at 5:1-2. Paganelli further teaches that the adhesive bond secures the reinforcing element to the tile so that the reinforcing element improves the tile's mechanical strength, toughness, and impact resistance. *Id.* at 4:4-10, 11:65-12:6. Indeed, Paganelli explains that improved adhesion between the reinforcing element and the tile's lower surface improves the reinforcing effect. *Id.* at 12:62-13:2. In addition, Paganelli [0025] describes a preferred embodiment where the metal sheet is covered with i) zinc or chromium plating, followed by ii) a layer of polymeric materials specifically epoxy resin, polyurethanes, polyvinyl, polyolefins or polyester with the intent purpose to serve as a protective layer from corrosion and enable use in wet environments.

169. Therefore, when Paganelli's covering element is used in its expressly disclosed outdoor or wet environments, the epoxy or polyurethane adhesive

necessarily maintains the bond required for the reinforcing element to perform its disclosed structural function. A POSITA therefore would have understood the waterproof character of the adhesive to be necessarily present in Paganelli's disclosed covering element, rather than merely a possible or optional modification.

iii. Claim 3 is anticipated by Paganelli.

a. “The method of claim 1, wherein the adhesive is waterproof.”

170. Paganelli discloses applying force across the entire substrate sheet when joining the reinforcing element to the porcelain tile. Paganelli teaches that “the reinforcing element is associated with, for example fixed, or preferably glued, to the lower surface of the tile” and that “the reinforcing element is fixed to the lower face of the tile by means of an adhesive.” EX1005 at 12:7-16. As explained above, Paganelli's tile is the claimed porcelain sheet, its lower face is the porcelain sheet's back side, and its reinforcing element is the claimed substrate sheet.

171. Paganelli teaches that reinforcing element 11 is fixed to lower surface 12 of tile 2 by adhesive and extends across substantially the entire lower surface of the tile, with its edges contained within the tile's perimeter. Paganelli at 12:7-16. Because the reinforcing element spans substantially the entire lower surface of the tile, obtaining the disclosed bonded assembly requires bringing and pressing the reinforcing element into adhesive contact with the tile across substantially its entire area. Otherwise, portions of the reinforcing element would remain unattached and

would not be “fixed” to the tile as Paganelli expressly requires. A POSITA therefore would understand that Paganelli’s adhesive joining process necessarily includes applying force across the reinforcing element, i.e., the claimed substrate sheet.

iv. Claim 4 is anticipated by Paganelli.

172. Paganelli incorporates Caselli by reference, as explained above, and thus anticipates this claim for the same reason as set forth in Sections VI.C.iv and VI.D.1.

v. Claim 5 is anticipated by Paganelli.

173. Paganelli incorporates Caselli by reference, as explained above, and thus anticipates this claim for the same reason as set forth in Sections VI.C.v and VI.D.1.

vi. Claim 6 is anticipated by Paganelli.

a. “The method of claim 1, wherein joining the surface of the porcelain sheet back side to the surface of the substrate sheet includes applying a force across the entire substrate sheet.”

174. Paganelli discloses that “[p]referably, the reinforcing element is fixed to the lower face of the tile by means of an adhesive, preferably a thermosetting resin, for example an epoxy, polyurethane, acrylic and/or hotmelt glue.” EX1005 at 4:4-23. A POSITA would generally understand that many hot-melt adhesives can develop usable bond strength very quickly and may reach their intended performance within 24 hours. Thus, Paganelli discloses the limitation of claim 6.

175. In addition, Caselli, which is incorporated by reference, expressly discloses a cure time (the “stocking time”) of “at least 0.5 [hours], preferably 1 [hour], for example 2 [hours]” (EX1004 at 23:3-10, 33:15-22), all of which fall squarely within the claimed range of “between about zero and about 24 hours.”

vii. Claim 7 is anticipated by Paganelli.

a. “wherein the substrate sheet is lightweight relative to the porcelain sheet.”

176. Paganelli teaches a porcelain tile joined to a substrate sheet that may be formed from plastic material, preferably rigid PVC. EX1005 at 6:1-3. Moreover, Paganelli’s incorporation of Caselli manufacturing method by reference as a disclosure of how to form Paganelli’s reinforcing element discloses that Paganelli’s reinforcing element is “light weight relative to” Paganelli’s porcelain tile for the reasons discussed.

viii. Claim 8 is anticipated by Paganelli.

a. “The method of claim 1, wherein the substrate is lightweight foam board relative to the porcelain sheet.”

177. Caselli informs Paganelli’s reinforcing element (board) as made of foam and “light weight relative to” Paganelli’s porcelain tile (porcelain sheet) for the reasons discussed.

178. Because Paganelli discloses a porcelain tile (EX1005 at 2:41-2, 11:16-17) joined to a rigid PVC substrate sheet (EX1005 at 6:1-3) and incorporates by

reference disclosures identifying such PVC support boards as made of foam and “low weight,” (EX1004 at 8:4-15), a POSITA would have understood the substrate sheet to be made of foam and lightweight relative to the porcelain sheet.

ix. Claim 9 is anticipated by Paganelli.

a. “wherein the stacking the substrate sheet and the porcelain sheet adjacently includes stacking the substrate sheet and the porcelain sheet horizontally.”

179. As explained for Limitation 1[b], “stacking,” as used in the 151 Patent, requires positioning the porcelain sheet and substrate sheet adjacent to one another with the porcelain sheet’s back-side surface facing a surface of the substrate sheet. *Supra* Section IX.C.ii.c. Paganelli discloses that arrangement because reinforcing element 11 is fixed to the lower surface 12 of tile 2 by adhesive. EX1005 at 4:8-10, 12:3-4. Paganelli’s Figures 2 and 3 depict tile 2 positioned above reinforcing element 11 with the opposing planar surfaces facing one another in a stacked relationship before and after adhesive joining. Moreover, Paganelli teaches that reinforcing element 11 extends beneath substantially the entire tile and is positioned within the tile’s perimeter. *Id.* at 12:7-16. The reinforcing element and tile are thus arranged as superimposed layers across substantially their entire overlapping surface area, confirming that Paganelli discloses the claimed stacked arrangement.

x. Claim 10 is anticipated by Paganelli.

- a. “wherein a cure time after joining the porcelain sheet back side to the surface of the substrate sheet is between about zero and about 10 minutes.”**

180. As explained above, this specific range is not supported by the specification of the 151 Patent, but to the extent it is, then Paganelli discloses it. Paganelli teaches fixing reinforcing element 11 to the lower surface 12 of tile 2 using an adhesive, including “epoxy, polyurethane, acrylic and/or hotmelt glue.” EX1005 at 4:8-12, 12:3-6. As explained above, Paganelli’s tile corresponds to the claimed porcelain sheet and its reinforcing element corresponds to the claimed substrate sheet. A POSITA would have understood that hotmelt glue is characterized by rapid setting and bond formation upon cooling, typically developing some degree of ultimate bond strength within about ten minutes of joining the substrates.

181. In my opinion, when practicing Paganelli's expressly disclosed hot-melt glue embodiment, a POSITA would understand that a bond between the porcelain tile and reinforcing element would develop usable handling strength rapidly following adhesive application, often within minutes as the hot-melt adhesive cools and solidifies. Accordingly, the bond could reasonably be expected to achieve a usable level of bond strength within a period between about zero and about 10 minutes.

xi. Claim 13 is anticipated by Paganelli.

a. 13[pre]: “A method of creating a surface covering, the method comprising:”

182. Paganelli discloses an “invention relate[d] to a covering element for floors . . . [and] a floor covering,” (EX1005 at 1:5-9) Paganelli discloses steps of method Claim 13 in its incorporated WO 2010/072704’s (EX1009) manufacturing method steps.

183. Paganelli discloses the steps of method Claim 13 in its incorporated Caselli same basic process.

b. 13[a]: “selecting a porcelain sheet having a porcelain finished side and a porcelain back side;”

184. Paganelli discloses selecting (a porcelain tile (EX1005 at 2:41-42) having “an upper decorative surface” (*id.* at 2:48-50) (porcelain finished side) and “a lower surface” (*id.* at 2:59-61) (porcelain back side), meeting every limitation 13[a].

c. 13[b]: “selecting a foam board having a board back surface and board side surfaces,”

185. Paganelli discloses a supporting element of “rigid PVC” (EX1005 at 6:2-3)—a material commonly manufactured as a foam board.

186. Having the same shape as the tile (EX1005 at 6:8-9) and thus possessing a back surface and side (edge) surfaces. A POSITA would understand rigid PVC board to encompass PVC foam board.

d. 13[c]: “wherein the foam board is up to an eighth of an inch different in length and width than the porcelain sheet;”

187. Paganelli discloses that the reinforcing element (and its supporting element) has “substantially the same” size as the tile (EX1005 at 6:8-9) but is “slightly smaller” with its edges “not project[ing] beyond the [tile’s edges]” (*id.* at 6:13-17)—meaning the reinforcing element’s edges are inset at a minimal length from the tile’s edges, as explained in greater detail above. A POSITA would understand these minimal differences between the tile’s and porcelain’s lengths and the tile’s and porcelain’s widths fall within the claimed range of up to one-eighth of an inch.

e. 13[d]: “applying an adhesive to the porcelain back side,”

188. Paganelli teaches applying an “adhesive” (e.g., “thermosetting resin [such as] epoxy, polyurethane, acrylic, and/or hotmelt glue”) to the “lower surface” (porcelain back side) “of the [porcelain] tile” to bond the reinforcing/supporting element, directly disclosing this element. See EX1005 at 2:41-42 (disclosing porcelain tile), 4:6-12 (containing quotations of previous sentence).

f. 13[e]: “locating the board back surface adjacent to the porcelain back side; and”

189. Paganelli discloses that the reinforcing element (including its supporting element) is placed directly against and fixed to the lower surface of the porcelain tile (EX1005 at 12:3-6), i.e., one surface of the board (the board back

surface) is located adjacent to the porcelain back side. Paganelli also expressly distinguishes between an “upper decorative surface” of the tile and a “lower surface” positioned opposite that decorative surface. EX1005 at 2:48-61. Paganelli also teaches fixing the reinforcing element to that “lower surface of the tile,” further confirming that it is the back-side surface of the tile rather than the decorative viewing surface. See *id.* at 4:6-8. A POSITA would understand these disclosures mean that Paganelli’s board’s back surface is located adjacent to the tile’s back side.

g. 13[f]: “applying compressive force across both the porcelain back side and the board back surface to adhere the foam board to the porcelain sheet,”

190. Paganelli discloses fixing the reinforcing element to the tile’s “lower surface” under a “compressive state” “by means of an adhesive, preferably a thermosetting resin.” EX1005 at 12:3-5. Compressively bonding the supporting element to the tile with a thermosetting adhesive requires the application of compressive force across both the tile’s lower surface and the supporting element’s surface to achieve proper adhesion.

h. 13[g]: “wherein the foam board is up to an eighth of an inch smaller in length and width than the porcelain sheet, and”

191. Paganelli expressly teaches that the reinforcing element is “slightly smaller” than the tile such that its edges “do not project beyond the edges of” (EX1005 at 6:12-17) and are fully “contained within the perimeter of” (*id.* at 12:14-

16) the tile. This slight dimensional difference is consistent with a difference of up to one-eighth of an inch, satisfying 13[g].

i. 13[h]: “wherein the porcelain sheet does not contact the board side surfaces.”

192. Because Paganelli’s reinforcing element is slightly smaller than and superimposed beneath the tile, the tile’s lower surface extends beyond the edges of the reinforcing element rather than wrapping around them.

xii. Claim 14 is anticipated by Paganelli.

a. “The method of claim 13, wherein the adhesive is waterproof.”

193. Paganelli discloses that the adhesive used to bond the reinforcing element to the tile is a thermosetting resin such as epoxy or polyurethane. EX1005 at 4:8-11. A POSITA would understand that epoxy and polyurethane resins are waterproof adhesives.

xiii. Claim 15 is anticipated by Paganelli.

194. Paganelli incorporates Caselli by reference, as explained above, and thus anticipates this claim for the same reason as set forth in Sections VI.C.iv and VI.D.xi.

xiv. Claim 16 is anticipated by Paganelli.

195. Paganelli incorporates Caselli by reference, as explained above, and thus anticipates this claim for the same reason as set forth in Sections VI.C.v and VI.D.xi.

xv. Claim 17 is anticipated by Paganelli.

- a. “The method of claim 13, wherein a cure time after joining the porcelain back side to the board back surface is between about zero and about 24 hours.”**

196. Paganelli satisfies this dependent limitation via its incorporation of the Caselli, which discloses a cure time of “at least 0.5 hours” (EX1004 at 23:3-9, 33:15-22, 40:5-11)—within the claimed range of “between about zero and about 24 hours.”

xvi. Claim 18 is anticipated by Paganelli.

- a. “The method of claim 13, wherein the foam board is waterproof.”**

197. Paganelli discloses a foam board, as discussed above. Paganelli’s incorporation of the Caselli’s manufacturing method (EX1005 at 6:3-7) also discloses Paganelli’s reinforcing element (board) as made of foam for the reasons discussed above. Paganelli also discloses its covering element as “made suitable for use outside and/or in wet environments.” EX1005 at 5:1-2. A POSITA would understand this disclosure to disclose that the covering element’s reinforcing element (board) is waterproof.

198. Paganelli also satisfies the “waterproof” part of this dependent limitation via its incorporation of Caselli’s board preferably “made of a waterproof material” (EX1004 at 8:1-3) and substrate that is preferably “waterproof” (*id.* at 9:24).

xvii. Claim 19 is anticipated by Paganelli.

- a. “The method of claim 13, wherein the foam board is lightweight relative to the porcelain sheet.”**

199. Paganelli’s discloses this limitation and anticipates claim 19 for the reasons discussed above.

xviii. Claim 20 is anticipated by Paganelli.

- a. “The method of claim 13, wherein the locating the board back surface and the porcelain back side adjacently includes locating the foam board and the porcelain sheet horizontally.”**

200. Paganelli discloses its tile (porcelain) as having “a substantially rectangular shape, square for example.” EX1005 at 11:22-23. Paganelli discloses its reinforcing element (board) as having “substantially the same horizontal shape and/or size (in plan view) as the tile” and that “the tile and the reinforcing element are superimposed so that, in use, the reinforcing element is substantially concealed by the tile.” EX1005 at 6:8-12. A POSITA would understand that—for a rectangular/square tile superimposed over a rectangular/square reinforcing element that is substantially the same size and shape as the tile—this superimposition, in which “the reinforcing element is substantially concealed by the tile,” necessitates horizontally locating the tile over the board; without horizontally locating the square tile over the square board that is substantially the same size of the tile, the tile would likely not be concealed by the tile.

201. Paganelli further explains that “the reinforcing element 11 is associated in an off-center way with the tile 2.” *Id.* at 13:5-7. A POSITA would understand this disclosure to refer to the horizontal positioning of the reinforcing element relative to the tile.

202. Moreover, Paganelli’s figures 1, 4, and 5 each depict its tile located horizontally over its reinforcing element. Because each surface edge of tile is shown parallel to each edge of the reinforcing element in these figures, a POSITA viewing them would understand them to expressly disclose “locating foam board and the porcelain sheet horizontally.”

E. Ground 5: Claims 11-12 Are Anticipated by or Obvious Over Couturier

i. Claim 11 is anticipated by Couturier.

a. Preamble: “A method of creating a surface covering, the method consisting of:”

203. Couturier describes a method for manufacturing tiles that includes adhering ceramic tiles to a foam substrate. EX1006 at [0020]. Couturier’s installed tile-and-substrate assembly is a “surface covering.” *See id.* Thus, Couturier’s disclosed installation method creates the claimed surface covering, and to the extent that the preamble is limiting, Couturier discloses this limitation.

b. Limitation 11[a]: “selecting a porcelain sheet with a porcelain back side;”

204. Couturier expressly discusses “porcelain tiles” and states that “most porcelain tiles have a ribbed or patterned surface” on their backside surfaces. EX1006 at [0009]. Its method applies to “ceramic tiles,” which a POSITA would understand to include porcelain tiles.

205. A porcelain tile is a planar porcelain article and therefore qualifies as a “porcelain sheet.” Because Couturier expressly identifies both porcelain tiles and their back surfaces, selecting such a tile is necessarily implicit in performing Couturier’s disclosed method (*id.* at [0020]) with the porcelain tiles Couturier identifies (*id.* at [0009]).

c. Limitation 11[b]: “selecting a foam board having a board back surface and board side surfaces;”

206. A POSITA would understand that the polyolefin foam carrier can be characterized as the claimed “foam board” because it is a discrete, planar foam body possessing two opposed major surfaces and intervening side surfaces.

207. A POSITA would also understand that the “board back surface” of 151 Patent’s Claim 11 to encompass Courier’s “first surface” facing the “back surface of a tile” because Claim 11 defines that surface through its relationship to the porcelain back (i.e., “the porcelain back side faces the board back surface,” 151 Patent at Claim 11).

d. Limitation 11[c]: “applying an adhesive to the porcelain back side;”

208. Couturier’s preferred embodiment of its claimed method directs the installer to adhere the adhesive membrane (i.e., a foam carrier with its first surface and second surface coated with adhesive) to the tile’s back surface using “pressure sensitive adhesive.” EX1006 at [0020]. A POSITA would understand that applying a pressure-sensitive-adhesive-coated membrane to the porcelain back applies adhesive to that back side.

e. Limitation 11[d]: “stacking the porcelain sheet and the foam board so the porcelain back side faces the board back surface; and”

209. Couturier’s preferred embodiment of its claimed method directs a manufacturer/installer to adhere the membrane to the back of the tile and then press the tile’s back surface toward the tiling substrate with the foam-containing membrane between them. EX1006 at [0020]. Couturier’s distinguishment of the foam carrier’s “tile side” from its opposite “wall side,” confirms that one major foam surface faces the tile back. *See id.*

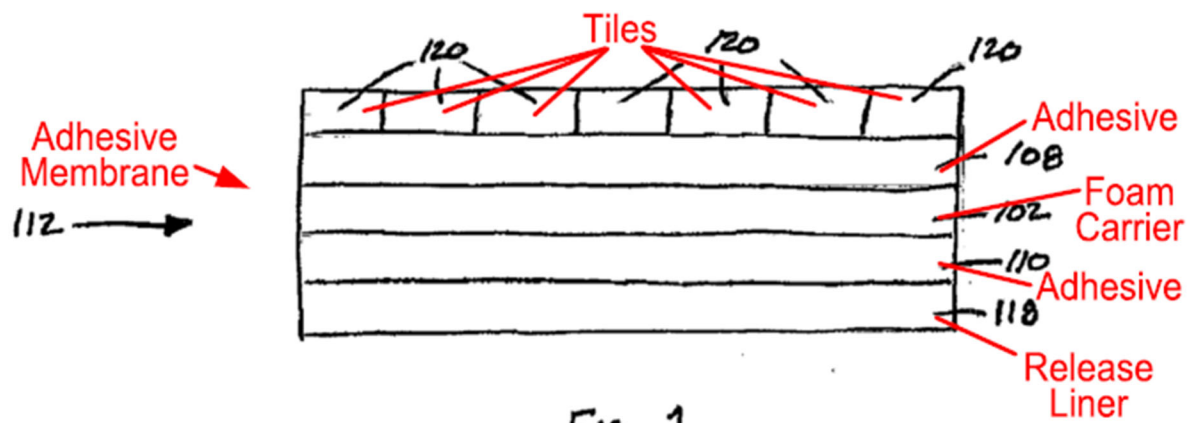
f. Limitation 11[e]: “joining the porcelain back side to the board back surface,”

210. In describing its preferred embodiment of its claimed method, Couturier states that the tile-side adhesive must wet out the back of the tile to provide good contact and hold the tile in place. EX1006 at [0021]. Its examples place the tile on the exposed adhesive and roll it three times to establish adhesion. *E.g.*, EX1006

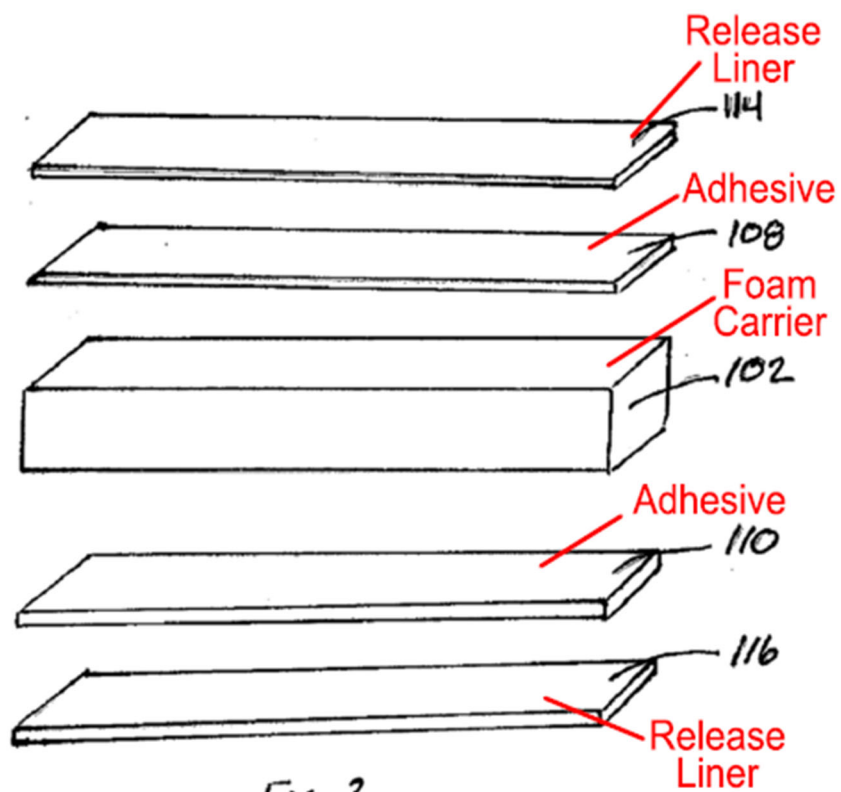
at [0035], [0037]. Couturier's method claim 9 expressly requires the adhesive on the foam carrier's first surface to be adhered to the tile's back surface. A POSITA would understand that applying Couturier's pressure-sensitive adhesive in this manner and applying a rolling force to porcelain tile placed atop the foam carrier, with the adhesive sandwiched between the tile's back side and the foam carrier, joins the porcelain tile's back to the foam carrier's tile-facing "first surface."

g. Limitation 11[f]: "wherein the porcelain sheet does not contact the board side surfaces."

211. As shown below, Couturier repeatedly describes the tile as being adhered to the foam carrier through the tile's back surface and the carrier's tile-side surface, with the adhesive membrane positioned between the tile and the substrate. EX1006 at FIG. 1 (depicting the tiles lying over the adhesive membrane's major surface, with the membrane positioned between the tiles and wall substrate), FIG. 2 (depicting the membrane as opposed adhesive layers on the foam carrier's major surfaces), [0020] (describing the tile as being adhered to the foam carrier through the tile's "back surface" and the foam carrier's tile-side surface). These disclosures place a tile flat on the membrane's exposed adhesive rather than wrapping the tile around the foam carrier's edges. In the depicted and described planar stack, the tile back faces and is joined to a major surface of the foam carrier; the tile does not wrap around and contact the carrier's side edges.



Couturier, FIG. 1 (annotated)



Couturier, FIG. 2 (annotated)

ii. Claim 12 Is Anticipated by Couturier

- a. Claim 12: “The method of claim 11, wherein joining the porcelain sheet to the foam board includes applying compressive force across both the porcelain sheet and the foam board to adhere the foam board to the porcelain sheet.”**

212. Couturier expressly explains that the foam carrier “assists in providing contact with the tile [] by compressing upon application of the tile.” EX1006 at [0021]. Couturier’s preferred embodiment of its claimed method directs a manufacturer/installer to press the tile’s back surface against the assembly, with the foam-containing adhesive membrane between the tile and substrate. *Id.* at [0020]. Its examples place the tile on the exposed adhesive and roll it three times with a roller to establish adhesion. EX1006 at [0035], [0037].

213. The roller applies compressive force to the outward face of the tile while the foam membrane is supported beneath it. That force is transmitted across the tile and into the foam carrier, causing the foam to compress and the tile-side adhesive to wet out the tile’s back surface.

iii. Claims 11 and 12 are Obvious Over Couturier

214. Even if it was argued that Couturier does not anticipate Claims 11-12, a POSITA would find these claims obvious in view of his/her knowledge at the effective filing date. Although Couturier may disclose other steps besides those just discussed, a POSITA would have found it obvious to omit those additional steps to arrive at those in method Claims 11-12.

F. Ground 6: Claims 1-20 Are Invalid Under 35 U.S.C. § 103 as Obvious over Caselli in View of the wedi 610 Technical Datasheet, Van Heugten, Paganelli, and Calvo

i. Claims 1-12 Are Invalid Under 35 U.S.C. § 103 as Obvious over Caselli in View of a POSITA's Knowledge at the Effective Filing Date.

215. Claims 1-12 are anticipated by Caselli (*see Supra* Section IX.C.ii, iv-viii, x, xi-xii), but assuming *in arguendo* any of these claims is/are not, a POSITA would find them obvious based on his/her knowledge at the effective filing date.

ii. Claim 2 is obvious over Caselli in view of the wedi 610[®] Technical Datasheet.

a. “The method of claim 1, wherein the adhesive is waterproof.”

216. As discussed above in Section VI.C.ii, Caselli discloses an epoxy resin adhesive for bonding the porcelain decorative layer to the board and emphasizes that the resulting floor covering is waterproof. A POSITA would understand that the disclosed epoxy resin adhesive is waterproof, and it would have been obvious to select a waterproof adhesive to achieve the impermeable floor covering Caselli teaches.

217. As just one example, the wedi 610[®] Technical Data Sheet (June 2016) confirms that waterproof adhesives for bonding tiles and building boards were well-known in the art before the effective filing date. The wedi 610[®] adhesive sealant involves chemical crosslinking reaction of a silane-terminated polymer adhesive through contact with moisture and is expressly marketed for “[w]aterproof adhesion”

of tiles to building boards and is described as “water-resistant” and intended “[f]or attachment of various materials including . . . soft PVC and tiles to the wedi building board.” EX1010, wedi 610[®] Technical Data Sheet at 1. A POSITA seeking to achieve the “totally impermeable” floor covering taught by Caselli (EX1004 at 20:29-32) would have been motivated to select a known waterproof adhesive—such as the wedi 610[®] adhesive or a similar commercially available waterproof adhesive—to bond a porcelain sheet to a foam board, with a reasonable expectation of success.

iii. Claim 3 is obvious over Caselli in view of Calvo.

a. Claim 3: “The method of claim 1, wherein joining the surface of the porcelain sheet back side to the surface of the substrate sheet includes applying a force across the entire substrate sheet.”

218. Caselli teaches pressing a ceramic decorative layer and a board together using either a static press (with a mold and punch) or a lamination belt or roller(s) to bond the layers and permeate the resin into the decorative layer. EX1004 at 22:52-62. Calvo supplements this by expressly teaching that after the porcelain sheet is adhered to the substrate, the laminate assembly is placed under pressure using “a metal bench or plate with the same dimensions as the laminate obtained” (EX1007 ¶ 107), which a POSITA would understand constitutes applying a force across the entire substrate sheet.

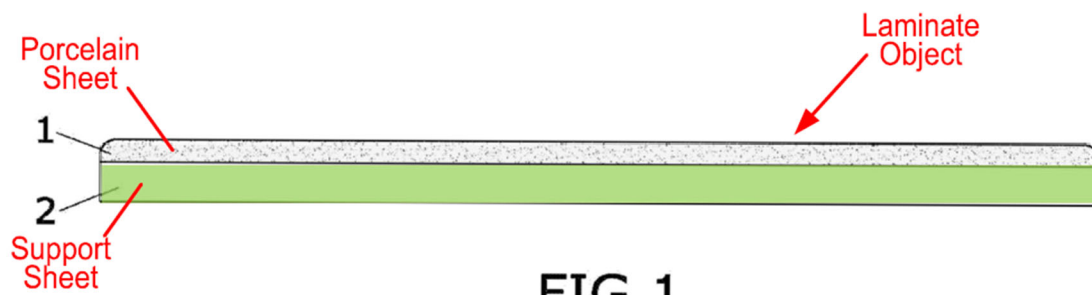
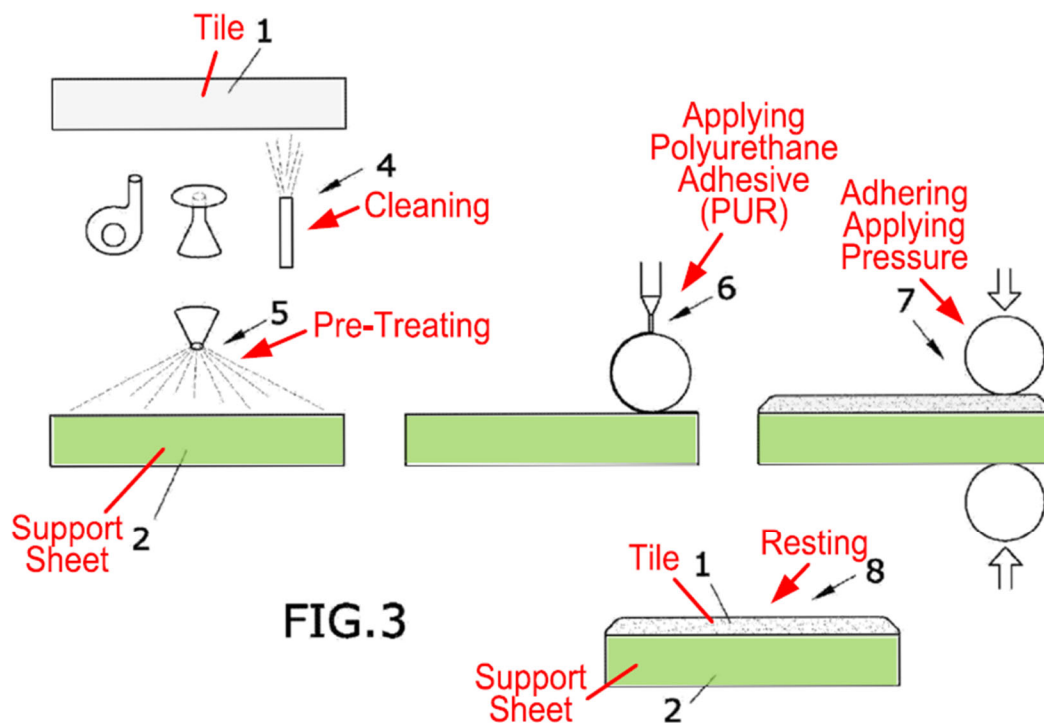


FIG. 1
Calvo, FIG. 1 (annotated)



FIG. 2
Calvo, FIG. 2 (annotated)



Calvo, FIG. 3 (annotated)

219. A POSITA would have been motivated to combine Calvo's teaching of uniform, full-surface pressing with Caselli's static press or lamination method because applying force across the entire substrate promotes Caselli's express goals of improved permeation and deep penetration of the adhesive into the decorative layer's entire surface (*see* EX1004 at 22:32-36, 22:50-51, 22:56-57), prevents delamination by promoting adhesive curing across the entire decorative layer (*see* EX1004 at 23:13-15, 23:20-22, 23:32-33), and promotes 100% coverage of the resin over the decorative layer's lower surface (*see* EX1004 at 22:27-30, 22:39-41, 33:9-11).

iv. Claim 4 is obvious over Caselli in view of Calvo.

- a. Claim 4: “The method of claim 3, wherein the force applied across the entire substrate sheet is between about thirty pounds per square inch and about forty pounds per square inch.”**

220. Caselli discloses that exerting “a pressure of at least 350 kg/sqm” onto its board and decorative layers during its pressing step. EX1004 at 22:24-26. 350-370 kilograms per square meter is equivalent to about 0.5 psi. Caselli’s disclosure of using a pressure of at least 0.5 psi during its pressing step includes a pressure between 30-40 psi because this range is greater than 350 kg/sqm (about 0.5 psi).

221. A POSITA would have been motivated to apply Calvo’s teaching of uniform, full-surface pressing with Caselli’s static press or lamination method, and such application would constitute applying a force across the entire substrate sheet.

v. Claim 5 is obvious over Caselli in view of Calvo.

- a. Claim 5: “The method of claim 3, wherein the compressive force is not applied during a cure time of the adhesive.”**

222. As noted above in Section VI.C.v, a POSITA would understand that the resin continues to cure after the floor element is no longer being compressed, resulting in the compressive force not being applied during a cure time of the adhesive. In addition, Caselli teaches that the resin itself generates compressive force during curing. EX1004 at 16:28-31. Because Caselli’s resin shrinkage

independently supplies compressive force during cure, a POSITA would find externally applied force unnecessary.

223. Both Calvo and Caselli contemplate foam substrates, and Calvo teaches that a “high density foam” substrate requires only 5-7 kg/cm² of pressure to achieve adhesion. EX1007 at 4:29-38. A POSITA would therefore be motivated to release external force before cure, thereby reducing process complexity and cost while allowing Caselli’s resin-shrinkage mechanism to reinforce the bond.

vi. Claim 8 is obvious over Caselli in View of Van Heugten.

a. Claim 8: “The method of claim 1, wherein the substrate is lightweight foam board relative to the porcelain sheet.”

224. As explained in detail, Caselli discloses that its polymeric—preferably PVC—board (substrate) is lightweight compared to its porcelain decorative layer (porcelain sheet). Van Heugten teaches that its backing layer (board) can be manufactured from “foamed plastic [], such as, . . . PVC.” EX1008 at 3:16-17. A POSITA would have understood that a foam PVC board, as taught by Caselli in view of Van Heugten, with a similar surface area as Caselli’s disclosed porcelain decorative layer (EX1004 at 11:4-6) (porcelain sheet) is lightweight compared to the porcelain decorative layer.

vii. Claim 13 is obvious over Caselli in view of Van Heugten.

a. 13[pre]: “A method of creating a surface covering, the method comprising:”

225. Caselli discloses “a method for manufacturing a floor element comprising the steps of: providing a decorative layer made of a ceramic material; providing a board; providing a resin material for bonding the decorative layer and the board together; pressing the layers together for forming the floor element such that the resin material permeates the ceramic layer.” EX1004 at 20:48-55.

b. 13[a]: “selecting a porcelain sheet having a porcelain finished side and a porcelain back side;”

226. Caselli discloses “the step[] of providing the decorative layer made of ceramic material” in its “method for manufacturing a floor element” (EX1004 at 20:45-51) and that “the ceramic tile of the decorative layer . . . is made from porcelain” (*id.* at 11:4-6). Caselli also discloses that “The decorative layer has an upper face comprising a décor” and a lower surface that is non-visible in use and that is “opposite to the upper decorative surface of the decorative layer” (*id.* at 11:38-40).

227. Caselli thus discloses providing (i.e., selecting) a decorative layer made of porcelain as the first step of its manufacturing method. The porcelain tile has an upper face with a decor (finished side) and an opposite lower surface (back side).

c. 13[b]: “selecting a foam board having a board back surface and board side surfaces,”

228. Caselli discloses “the step[] of . . . providing a board” in its “method for manufacturing a floor element” (EX1004 at 20:45-52) and explains that the board is made of a compressible polymeric material—an ideal material because it has mechanical properties well suited for use as a subfloor board in a manufactured floor element, is relatively inexpensive and lightweight, and “provide[s] for an impermeable and sound reducing board.” EX1004 at 8:1-8. Caselli further explains that “[f]orming the board out of a material with a relatively low glass transition temperature,” such as thermoplastic polymeric material (e.g., “PVC (polyvinyl chloride),” “polyurethane,” “polyethylene, polypropylene, [or] polyethylene terephthalate”) “leads to a board which is easily compressed at room temperature.” *Id.* at 8:9-18.

229. Caselli describes the shape of its board as “basically corresponding to [that of] the decorative layer, however, preferably, with one or more portions extending beyond the decorative layer.” *Id.* at 13:48-50. Since Caselli describes its decorative layer as having “an upper face” (*id.* at 12:1) and a “lower surface . . . that is opposite to the upper decorative surface of the decorative layer” (*id.* at 11:38-40), Caselli teaches that its board likewise has a back surface opposite its upper surface. Van Heugten teaches that its backing layer (board) can be manufactured from “foamed plastic [], such as, . . . PVC.” EX1008 at 3:16-17.

230. A POSITA reading Caselli in view of Van Heugten would be motivated to use a foamed version of Caselli’s disclosed PVC—like Van Heugten’s disclosed backing layer board made of foamed PVC—board material because foamed PVC is highly compressible, and Caselli expressly identifies compressibility as a desired attribute of its subfloor board.

231. A POSITA would reasonably expect success in this combination because foamed PVC is simply a well-known variant of the same PVC material Caselli already discloses for its board, and substituting a foamed form of PVC would not alter the board’s function or its compatibility with Caselli’s disclosed manufacturing method—it would merely enhance the compressibility that Caselli itself identifies as desirable.

d. 13[c]: “wherein the foam board is up to an eighth of an inch different in length and width than the porcelain sheet;”

232. The “foam board” of limitation 13[c] corresponds to the “substrate sheet” of limitation 1[d], and the operative dimensional relationship—requiring the board to differ from the porcelain sheet by no more than one-eighth of an inch in length and width—is substantively the same. For the reasons discussed above in Section VI.C.i (discussing limitation 1[d]), Caselli’s disclosures regarding the board extending beyond the decorative layer by a distance DI satisfy limitation 13[c].

e. 13[d]: “applying an adhesive to the porcelain back side;”

233. Caselli discloses “step S1,” in which uncured resin (adhesive) is applied onto the lower surface (back side) of the porcelain decorative layer. EX1004 at 32:53-58. This directly discloses the claimed step of “applying an adhesive to the porcelain back side,” as fully explained above (discussing limitation 1[a]).

f. 13[e]: “locating the board back surface adjacent to the porcelain back side; and”

234. Caselli discloses “step S2,” in which the board is placed below the lower surface of the porcelain decorative layer to form a “semi-finished sandwich,” with the surface of the board (its “back surface” in the orientation of the claimed method) facing (adjacent to) the decorative layer (porcelain) back side. Caselli at 32:64-67; *see* above (discussing limitation 1[b]).

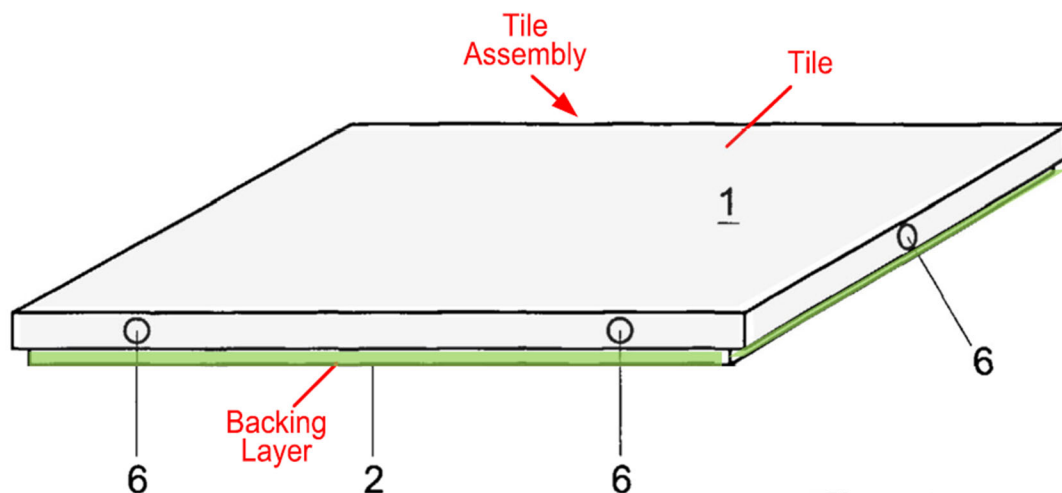
g. 13[f]: “applying compressive force across both the porcelain back side and the board back surface to adhere the foam board to the porcelain sheet,”

235. Caselli’s disclosure of step s3 pressing the stacked layers together (step S3) using a static press or lamination equipment. EX1004 at 22:51-62, 33:2-7; *see also* above (discussing Claim 12). This compressive force is applied across both the porcelain decorative layer’s back side and the board back surface—*see* above (discussing “semi-finished sandwich” orientation with the board’s back surface facing the decorative layer’s back side)—to cause the adhesive/resin to permeate the

ceramic (porcelain) and bond the layers together, thereby adhering the board to the porcelain sheet. EX1004 at 33:2-7.

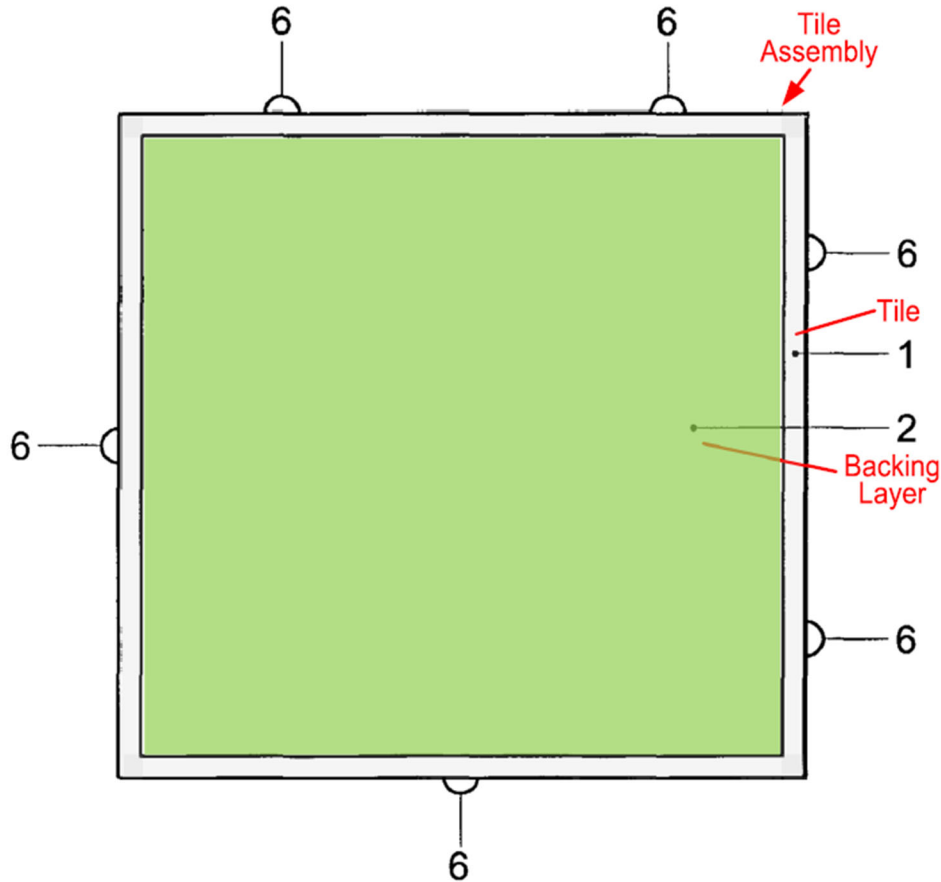
h. 13[g]: “wherein the foam board is up to an eighth of an inch smaller in length and width than the porcelain sheet, and”

236. Caselli discloses an embodiment where the board is larger in length and width than the porcelain, but arguably does not disclose “smaller.” Van Heugten discloses that its “backing layer,” which can be manufactured of “foamed plastic” (EX1008 at 3:16-17), has “width and length dimensions . . . [that] are slightly smaller than the width and length dimensions of the respective tile” (id. at 3:21-27), as shown explicitly below in Figures 1 and 2. In addition, Paganelli also discloses a system with a foam board that is smaller in length and width than the porcelain sheet. Section VI.D above.



Van Heugten, FIG. 1 (annotated)

Fig. 1



Van Heugten, FIG. 2 (annotated)

Fig. 2

237. A POSITA would be motivated to combine Caselli’s floor element manufacturing method with Van Heugten’s or Paganelli’s teaching of making the backing layer (board) slightly shorter in length and width than the tile (porcelain sheet) because, as Van Heugten explains, this design choice “simplifies the manufacture of the tile” since it creates a dimensional tolerance between the backing layer and the tile, “mak[ing] it simpler to place a layer of backing material on the tile

1 for manufacturing a tile according to the invention, in that the positioning of the layer 2 is less critical.” EX1008 at 3:21-27, 4:14-17, 6:2-6.

238. A POSITA would have reasonably expected that the manufacturing method of Caselli, when combined with this teaching of Van Heugten or Paganelli, would succeed because each of the references relate to composite tile panels with a backing layer adhered to a decorative porcelain tile, and reducing the backing layer dimensions relative to the tile is a straightforward dimensional modification that does not alter the underlying adhesion or assembly process disclosed by Caselli.

i. 13[h]: “wherein the porcelain sheet does not contact the board side surfaces.”

239. Caselli discloses that its porcelain decorative layer “does not contact the board side surfaces” because of the differing lengths and widths of its decorative layer and board, its board’s side surfaces are manufactured for coupling with other board side surfaces, and its adhesive is only applied between its board and decorative layer. *See* above (discussing limitation 1[e]). While Caselli’s differing lengths and widths are due to the its decorative layer being inset from its backing board, Van Heugten discloses that its backing layer is inset from its tile. EX1008 at 3:21-27. Van Heugten thus teaches manufacturing its tile assembly so its flat tile (porcelain sheet) does not contact its backing layer (board) because a POSITA reading Van Heugten would understand that the tile contacts its backing board only where the

backing board surface faces and is adhered to the tile's back and that the tile does not contact the backing layer's side surfaces.

viii. Claim 14 is obvious over Caselli in view of the wedi 610® Technical Data Sheet and Van Heugten.

a. Claim 14: “The method of claim 13, wherein the adhesive is waterproof.”

240. Claim 14 would have been obvious to a POSITA for the same reasons set forth above with respect to Claim 2.

ix. Claim 15 is obvious over Caselli in view of Van Heugten.

a. Claim 15: “The method of claim 13, wherein the compressive force is between about thirty pounds per square inch and about forty pounds per square inch.”

241. Claim 15 would have been obvious to a POSITA for the same reasons set forth above with respect to Claim 4.

x. Claim 16 is obvious over Caselli in view of Van Heugten.

242. Claim 16 would have been obvious to a POSITA for the same reasons set forth above with respect to Claim 5.

xi. Claim 17 is obvious over Caselli in view of Van Heugten.

a. Claim 17: “The method of claim 13, wherein a cure time after joining the porcelain back side to the board back surface is between about zero and about 24 hours.”

243. Claim 17 would have been obvious to a POSITA for the same reasons set forth above with respect to Claim 6.

xii. Claim 18 is obvious over Caselli in view of Van Heugten.

a. Claim 18: “The method of claim 13, wherein the foam board is waterproof.”

244. Caselli expressly teaches that the board is “made of a waterproof material” (EX1004 at 8:1-4) and that the substrate is preferably “waterproof” (*id.* at 9:24). Caselli further confirms that the preferred PVC polymeric board is “impermeable.” *Id.* at 8:5-12. Van Heugten teaches that its backing layer (board) can be manufactured from “foamed plastic [], such as, . . . PVC.” EX1008 at 3:16-17. A POSITA reading Caselli in view of Van Heugten would have understood this combination of teachings to teach that the foam-PVC variety of Caselli’s impermeable PVC board is waterproof. Claim 14 would have been obvious to a POSITA for the same reasons set forth above with respect to Claim 2.

xiii. Claim 19 is obvious over Caselli in view of Van Heugten.

a. Claim 19: “The method of claim 13, wherein the foam board is lightweight relative to the porcelain sheet.”

245. As explained above with respect to Claim 7, Caselli discloses that its polymeric—preferably PVC—board (substrate) is lightweight compared to its porcelain decorative layer (porcelain sheet). Van Heugten teaches that its backing layer (board) can be manufactured from “foamed plastic [], such as, . . . PVC.” EX1008 at 3:16-17. A POSITA would have understood that a foam PVC board, as taught by Caselli in view of Van Heugten, with a similar surface area as Caselli’s

disclosed porcelain decorative layer (EX1004 at 11:4-6) (porcelain sheet) is lightweight compared to the porcelain decorative layer.

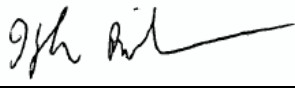
xiv. Claim 20 is obvious over Caselli in view of Van Heugten.

a. Claim 20: “The method of claim 13, wherein the locating the board back surface and the porcelain back side adjacently includes locating the foam board and the porcelain sheet horizontally.”

246. Caselli’s manufacturing method discloses that the decorative (porcelain) layer is placed face-down horizontally, and the board is then placed on top of the decorative layer’s lower (back) surface (EX1004 at 32:61-67)—i.e., the board back surface and the porcelain back side are located adjacently in a horizontal orientation before being pressed together. This horizontal layup process directly teaches “locating the [] board and the porcelain sheet horizontally” as recited in claim 20. As discussed above (discussing 13[b]), Casseli in view of Van Heugten teaches that the board is a foam board.

I hereby declare that all statements of my knowledge made in this declaration are true and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: September 9, 2026



Kyle Brinkman

APPENDIX

A

RESUME

Kyle Scott Brinkman

PERSONAL DATA

Steven H. ('77) and Mary K. Sigmon Family
Endowed Professor and Department Chair
Materials Science and Engineering
115 S. Palmetto Blvd.
AMIC: 2118
Clemson, SC 29634
(864)-656-1405 (office)
(843)-441-6643 (personal cell)
<https://www.clemson.edu/cecas/departments/mse/research/emrl/>

EDUCATION

Ph.D., Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, 2004, Materials Science and Engineering
M.S., Clemson University, 2000, Materials Science and Engineering
B.S., Clemson University, 1998, Chemical Engineering

PROFESSIONAL EXPERIENCE

Clemson University, January 2026-Present, Inaugural Steven H. ('77) and Mary K. Sigmon Family Endowed Professor and Department Chair of Materials Science and Engineering

Clemson University, March 2019-December 2025, Department Chair of Materials Science and Engineering,

- Led a team of 23 faculty, over 150 total undergraduate and graduate students, postdocs and research staff with an annual combined teaching and research budget in excess of \$11M.
- Led conceptual design through to construction and commissioning of \$130M new materials building opening in November 2025
- Developed vision for 3D X-ray based imaging lab, design, build and funding strategy with industry, governments and university partners as unique feature of building.
- Led successful ABET Undergraduate program accreditation reviews (2024) and GAPS Graduate program external reviews (2025)
- Excelled in philanthropy with the development team aiding in AMIC building, mid-career faculty funds, research support, and student fellowships/scholarships
- Established a strong EAB consisting of national CEOs and leaders in MSE field
- Hired 9 new MSE faculty (out of 23.5 FTEs total) representing ~40% faculty including expansion of "joint-appointment" program with AuE, ME
- Established the First external/outgoing joint appointment SRNL/BSRA in 2024

Clemson University, 2018-Present, Professor of Materials Science and Engineering

Clemson University, 2014-2018, Associate Professor of Materials Science and Engineering
Tenured (2016)

Savannah River National Laboratory, 2012-2014, Program Manager for Energy Efficiency and Renewable Energy

2011-2014, Principal Engineer, Science and Technology Directorate

2009-2011, Senior Engineer A, Materials Science and Technology Directorate

2008-2009, Senior Engineer, Materials Science and Technology Directorate

2007-2008, Postdoctoral Scholar, Energy Security Directorate

University of South Carolina, 2010-Present, Adjunct Professor and Graduate Faculty,
Department of Mechanical Engineering's Solid Oxide Fuel Cell Center

Advanced Industrial Science and Technology Institute (AIST), Tsukuba, Japan

2005-2007, Japanese Society for the Promotion of Science (JSPS) Postdoctoral Fellow

HONORS AND AWARDS

Fellow of Royal Society of Chemistry (FRSC), 2023

Academician World Academy of Ceramics, 2023

Fellow of the American Ceramic Society (ACerS), 2020

Navrotsky Award for Experimental Thermodynamics (ACerS), 2023

University Research, Scholarship and Artistic Achievement Awards (URSAA) 2023

Brimacombe Medalist Award, TMS Society, 2020

NETL-DOE ORISE Faculty Fellow DOE 2017

Murray Stokely Prize for Excellence in Teaching, 2018

Dean's Professorship Award from the Clemson College of Engineering, Computing, and Applied Sciences (2017-2020)

Karl Schwartzwalder-Professional Achievement in Ceramic Engineering (PACE) Award, American Ceramic Society and National Institute of Ceramic Engineers, ACerS/NICE (Top Ceramic Engineer in Country 40 or under) 2015

The Minerals, Metals and Materials Society (TMS) Young Leader International Scholar, 2015

Clemson University, College of Engineering and Science, Outstanding Young Alumni Award, 2015

Prior to Clemson

Fuel Cycle Research and Development (FCR&D) Early Career Researcher Award, DOE-NE, 2013

Laboratory Director's Early Career Exceptional Achievement Award, SRNL-DOE, 2011

IEA/HIA Project Prize for Fundamental Research 2010, team award by IEA to task H-25-Fundamental Safety Testing and Analysis of Hydrogen Storage Materials and Systems.

Young Leader Professional Development Award, TMS, 2010

Pacificchem Young Scientist Award, ACS, 2010

Savannah River National Laboratory "SPOT" Award, DOE-SRNL, 2010

Charmey Prize, Swiss University Prize for Surface Science, 2007

http://dmxwww.epfl.ch/SAOG/saog_2007/saog2007.html

Japanese Society for the Promotion of Science (JSPS), Postdoctoral Fellow Award, 2005

PROFESSIONAL ACTIVITIES

Leadership and Engagement

Atlantic Coast Conference Academic Leaders Network (ACC-ALN) selected to represent Clemson as part of 2024 cohort <https://news.clemson.edu/acc-academic-leaders-network-holds-its-first-2024-meeting-at-clemson/>

Presidents Leadership Institute PLI 2024-2025 Class. Selected by Clemson University President Jim Clements for 9th PLI cohort <https://news.clemson.edu/25-faculty-and-staff-chosen-for-the-2023-presidents-leadership-institute/>

Clemson Department Chair Academy, Instructor for inaugural 2024 Clemson Chair Academy, a leadership development community designed to cultivate leadership awareness, skills and styles for department chairs <https://news.clemson.edu/clemson-chair-academy-kicks-off-with-new-chair-onboarding-program/>

Member (Elected) Executive Committee University Materials Council (UMC), Organization of all Department Chairs of MSE in US/Canada, 2021-2024

Committee and Board Service

Editor Journal of Materials Science (Spring Nature Publishing), 2016-2024

Member External Advisory Board (EAB) for Materials Science and Engineering at i) University of Tennessee Knoxville 2022-Present and ii) Georgia Institute of Technology (Georgia Tech) 2024-Present

Founding Member and Steering Committee Thermodynamic Consortium

The Minerals, Metals and Materials Society (TMS), Elected Member, Government and External Affairs Committee, 2023-Present

American Ceramic Society (ACERS), Programming Committee, 2023-Present

American Ceramic Society (ACERS), Awards Committee for Selection of Navrotsky Award for Experimental Thermodynamics 2024-Present

American Ceramic Society (ACERS), Chair (2021), Vice Chair, newly created Energy Materials and Systems Division (EMSD), 2019-2020

The Minerals, Metals and Materials Society (TMS), Vice Chair (2014-2016); Chair, Energy Conversion and Storage Committee, 2016-2018

Secretary-Nuclear Environmental Technology Division ACERS (2018); representative to ACERS program committee

International Advisory Board for CIMTEC 2018 Forum on New Materials, Focused Session FK-10, Materials Issues in Nuclear Waste Treatment and Disposal, and CIMTEC 2022 Focused Session FR-10 Materials Issues in Radioactive Nuclear Waste Treatment and Disposal

American Ceramic Society, National Institute of Ceramic Engineers, Secretary, 2016-2018

ASM International, Chair, Engineering Materials Achievement Award 2015-2018 (member 2014-present)

Symposia Organization

American Ceramic Society (ACERS), Co- organizer of Energy Materials and Systems for Sustainable Development Columbus, OH 2021, Co-organizer MS&T Pittsburgh, PA 2022, Co-organizer MS&T Columbus OH 2023

American Ceramic Society (ACERS), Lead organizer of Thermodynamics of Materials in Extreme Environments MS&T Portland OR 2019; Co-organizer MS&T Pittsburgh, PA 2020, Co-organizer MS&T Columbus, OH 2021, Co-organizer MS&T Pittsburgh, PA 2022, Co-organizer MS&T Columbus OH 2023, Co-organizer MS&T Pittsburgh, PA 2024

American Ceramic Society (ACERS), Co-organizer, Nuclear Ceramics Symposium, 45th International Conference and Exposition on Advanced Ceramics (ICACC), Daytona, FL 2021, 2022 and 2023

American Ceramic Society (ACERS), MS&T, Co-organizer Ceramics in the Nuclear Fuel Cycle, Pittsburgh, PA 2020

The Minerals, Metals and Materials Society (TMS), Co- Organizer, High Temperature Material Systems for Energy Conversion and Storage, (Orlando, FL, March 2015); (Nashville, TN February 2016); (San Diego CA February 2017); (Pheonix, AZ 2018); (San Antonio, TX 2019); (San Diego, CA 2020)

The Minerals, Metals and Materials Society (TMS), Lead Organizer, High Temperature Material Systems for Energy Conversion and Storage, San Diego, CA, February 2014

The Minerals, Metals and Materials Society (TMS), Lead Organizer, Materials Science of Nuclear Waste Management, San Antonio, TX, March 2013

The Minerals, Metals and Materials Society (TMS), Chair, Young Leader Tutorial Luncheon, 2011-2012 ASM International, Chair, Savannah River Section, 2012

North American Membrane Society (NAMS), Co-organizer, Gas Separations, Annual Meeting, Charleston, SC 2009

MEMBERSHIPS

Member, The Minerals, Metals and Materials Society (TMS), 2009-Present
 Member, Materials Research Society, MRS, 1998-Present
 Member, ASM International, 2010-Present
 Member, American Ceramic Society (ACERS), 2010-Present
 Member, North American Membrane Society (NAMS), 2008-2012
 Member, United States-JSPS Fellows Alumni Association, 2012-Present
 Member, American Association for the Advancement of Science (AAAS), 2020-Present

PUBLICATIONS: (>130 peer reviewed papers, h-index 38, h-10 index 102, citations >4763)
Refereed Journal Publications

1. Mingyang Zhao, Xiao Chen, Huiping Zhu, Songqin Xia, Yan Ma, Kyle S. Brinkman, Zhenfeng Tong, “Unraveling Cs substitution-induced evolution in Fe-hollandite: Linking crystal chemistry to leaching resistance” *Journal American Ceramic Society* **2025**, 107 (7) e20447.
2. Karamullah Eisawi, Elham Loni, Saehwa Chong, Martin Liezers, Ming Tang, Kyle S Brinkman, Brian J Riley, Michael Naguib, “Nanohybrid of Silver-MXene: A Promising Sorbent for Iodine Gas Capture from Nuclear Waste” *Advanced Materials Interfaces*, **2025**, 2500011.
3. Jack H Duffy, Nancy Birkner, Chiyoun Kim, Ryan Jacobs, Dane Morgan, Shivani Sharma, Scott T Mixture, Erik M Kelder, Harry W Abernathy, Kyle S Brinkman, “Structural and thermodynamic analysis of triple conducting ceramic materials BaCo 0.4 Fe 0.4 Zr 0.2– XYXO 3– δ ” *Journal of Materials Chemistry A* **2025**, 13 (14), 10147-10159.
4. Benjamin W Tuffy, Nancy R Birkner, Juliano Schorne-Pinto, Ryan C Davis, Amir M Mofrad, Clara M Dixon, Mina Aziziha, Matthew S Christian, Timothy J Lynch, Maxwell T Bartlett, Theodore M Besmann, Kyle S Brinkman, Wilson KS Chiu, “Formation of β -U₃O₈ from UCl₃ Salt Compositions under Oxygen Exposure” *The Journal of Physical Chemistry B* **2025** 128 (45), 11174-11185
5. C.S. Dandeneau, R.Rajeev, A. Gootgeld, D.A. Hitchcock, L.C. Olson, T. Zhou, J. Tong, K.S. Brinkman, B.L. Garcia-Diaz, “Structural stability and electrochemical response of 3D printed and reactively sintered Ga-doped Li₇La₃Zr₂O₁₂ electrolytes” *Materials Letters* **2024** 375 137240
6. A.M. Mofrad, M.S. Christian, J. Schorne-Pinto, J. Amoroso, K.S. Brinkman, Hans-Conrad zur Loye, T.M. Besmann, Predictive phase stability of actinide-bearing hollandite waste forms from first-principles calculations” *Journal of Nuclear Materials* **2024** 600 155291
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Engineering the Electrolyte/Cathode Interface” *ACS Energy Letters* **2024** 9 (9) 4557-4563

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21. T. Lynch, N.R. Birkner, M.S. Christian, J.A. Wrubel, J. Schorne-Pinto, A. Van Veelen, J.R. Bargar, T.M. Besmann, K.S. Brinkman, WKS Chiu, “In Situ Determination of Speciation and Local Structure of NaCl–SrCl₂ and LiF–ZrF₄ Molten Salts” *The Journal of Physical Chemistry B* **2022**, 126 (7) 1539-1550.
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27. N Birkner, C Li, SL Estes, KS Brinkman, “Gallium-Doping Effects on Structure, Lithium-Conduction, and Thermochemical Stability of $\text{Li}_{7-3x}\text{Ga}_x\text{La}_3\text{Zr}_2\text{O}_{12}$ Garnet-Type Electrolytes” *ChemSusChem* **2021**, 14, 1-11.
28. M Zhao, E O'Quinn, N Birkner, Y Xu, M Lang, K Brinkman, “Radiation damage and thermal annealing in tunnel structured hollandite materials” *Acta Materialia* **2021**, 206, 116598.
29. Z Zhao, J Gao, Y Meng, KS Brinkman, J Tong, “Moderate temperature sintering of $\text{BaZr}_{0.8}\text{Y}_{0.2}\text{O}_{3-\delta}$ protonic ceramics by A novel cold sintering pretreatment” *Ceramics International* **2021**, 47 (8), 11313-11319.
30. M. Zhao, J. Amoroso, K.M. Fenker, D.P. DiPrete, S. Mixture, S. Utlak, T. Besmann, K. Brinkman “The effect of cesium content on the thermodynamic stability and chemical durability of $(\text{Ba,Cs})_{1.33}(\text{Al,Ti})_8\text{O}_{16}$ hollandite ” *Journal of the American Ceramic Society* **2020**, 103:7310–7321.
31. C Li, A Ishii, L Roy, D Hitchcock, Y Meng, K Brinkman “Solid-state reactive sintering of dense and highly conductive Ta-doped $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$ using CuO as a sintering aid” *Journal of Materials Science* **2020**, 55 (35), 16470-16481.
32. Ishii, A., Mu, S., Meng, Y., Huang, H., Lei, J., Li, Y., Peng, F., Xiao, H., Tong, J., Brinkman, K. S. “Rapid Laser Processing of Thin Sr-Doped LaCrO_3 Interconnects for Solid Oxide Fuel Cells” *Energy Technology* **2020**, 8 (10), 2000364.
33. Gao, J., Meng, Y., Benton, A., He, J., Jacobsohn, L. G., Tong, J., Brinkman, K. S. “Insights into the Proton Transport Mechanism in TiO_2 Simple Oxides by In Situ Raman Spectroscopy” *ACS Applied Materials & Interfaces* **2020**, 12(34), 38012-38018.
34. Shenglong Mu, Hua Huang, Akihiro Ishii, Yuzhe Hong, Aaron Santomauro, Zeyu Zhao, Minda Zou, Fei Peng, Kyle S Brinkman, Hai Xiao, Jianhua Tong “Rapid laser reactive sintering of $\text{BaCe}_{0.7}\text{Zr}_{0.1}\text{Y}_{0.1}\text{b}_{0.1}\text{O}_{3-\delta}$ electrolyte for protonic ceramic fuel cells” *Journal of Power Sources Advances* **2020**, 4, 100017.
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PRESENTATIONS (*109 contributed presentations*)

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2. Peyton McGuire, Kyle Brinkman “Structural Characterization of Novel Tin Fluorophosphate Nuclear Salt Waste Forms” Materials Research Society Fall Meeting Boston MA, Dec 2nd 2024.
3. Nakeshma Cassell, Nancy Birkner, Abhaya Mishra, Kyle Brinkman, “An Investigation of the Structure-Property Relations of Tunnel Structured Oxide” Thermodynamics of Materials in Extreme Environments, Materials Science and Technology (MS&T), Pittsburgh PA, 2024.
4. Peyton McGuire, Kyle Brinkman “Phosphate Glass Ceramic Waste Forms” at the International Commission on Glass (ICG), Glass for a Sustainable Future conference in Lloret de Mar, Spain April 28th-May 3rd, 2024.
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54. K.S Brinkman, K. Reifsnider, F. Chen, F. Rabbi, Y. Lin, W.. Chiu, W. Harris, D. Su, Y. S. Chu, J. Wang, Y. Chen-Wiegart, "Multi-Scale Membrane Design" Presented at the DOE-BES Energy Frontier Research Center (EFRC) Principal Investigator Meeting, Washington DC, July 18th and 19th (2013).
55. J. Amoroso, K. Brinkman, J. Marra, S. Sundaram, M. Tang, "Melt Processed Crystalline Ceramic Waste Forms" Waste Forms Working Group Meeting, Salt Lake City, Utah October 4th, (2013).
56. J. Amoroso, K. Brinkman, J. Marra, M. Tang, Melt processed ceramic waste forms for advanced nuclear fuel cycles" GLOBAL 2013: International Nuclear Fuel Cycle Conference Salt Lake City, Utah, USA, September 29th – October 3rd (2013).
57. K. Brinkman, K. Fox, J. Marra, J. Amoroso and M. Tang, "Melt Processed Crystalline Ceramic Waste Forms for an Advanced Nuclear Fuel Cycle" in the symposium Materials Science of Nuclear Waste Management at The Minerals, Metals and Materials Society (TMS) Annual meeting in San Antonio TX on March 3-7th (2013).
58. M. Tang, K. Brinkman, J. Crum, K. Fox, J. Marra, "Radiation Stability Study on Glass Ceramic and Crystalline Ceramic Waste Forms for an Advanced Nuclear Fuel Cycle" in the symposium Materials Science of Nuclear Waste Management at The Minerals, Metals and Materials Society (TMS) Annual meeting in San Antonio TX on March 3-7th (2013).
59. S. Wang, M. Tang, K. Brinkman, "Perovskite Structured Oxide for Simultaneous Incorporation of Fission Products" in the symposium Materials Science of Nuclear Waste Management at The Minerals, Metals and Materials Society (TMS) Annual meeting in San Antonio TX on March 3-7th (2013).
60. K. Brinkman, F. Rabbi, K. Reifsnider, "The Effect of Constituent, Interfacial Properties and Morphology on the Dielectric Response of MIEC Membranes" in the symposium Materials in Clean Power Systems VIII: Durability of Materials for Fuel Cells at The Minerals, Metals and Materials Society (TMS) Annual meeting in San Antonio TX on March 3-7th (2013).
61. K. Brinkman, K. Fox, J. Marr and M. Tang, "Progress in the development of crystalline ceramic waste forms for an advanced nuclear fuel cycle" Advanced Ceramics and Composites for Nuclear Applications- Ceramics and Glass for Waste Immobilization symposium of the 36th Annual International Conference and Exposition on Advanced Ceramics and Composites in Daytona Beach Florida January 22-27th (2012).

62. K. Brinkman, “Novel Methods of Hydrogen Isotope Sequestration: Proton Conducting Ceramic Separation Membranes in Next Generation Nuclear Energy Systems” Materials and Fuels for the Current and Advanced Nuclear Reactors Symposium at the 141st Annual TMS meeting in Orlando, FL March 11-16th (2012).
63. J. Reppert, K. Brinkman, A. Mendez-Torres, M.J. Martinez-Rodriguez, G. Weeks and D. Krementz, “Synthesis and Characterization of Smart Functional Coatings” Rare-Earth-based Materials: Symposium MRS Spring Meeting, San Francisco, CA April 12, (2012).
64. K. Reifsnider, Q. Liu, F. Rabbi, W. Chiu, K. Brinkman, “Role of Micromorphology and Interfacial Mismatch in the Design of Heterogeneous Functional Materials for Fuel Cell Applications” in the symposium Fuel Cell Science and Technologies at the 245th ACS National Meeting and Exposition in New Orleans, Louisiana April 7-11th (2013).
65. K. Reifsnider, K. Brinkman, Q. Liu, J. Adkins, J. Baker and F. Rabbi, “Relationship Of Micromorphology To Charge Storage And Transfer Properties In Heterogeneous Functional Materials: Design of Heterogeneous Functional Materials – HeteroFoam” 10th Annual World Congress on Computational Mechanics July 8-13th Sao Paulo Brazil (2012).
66. K. Reifsnider, K. Brinkman, “Multiphysics Functional Design of HeteroFoam Nanomaterials for Energy Systems Energy” Nanomaterials Symposium at the 141st Annual TMS meeting in Orlando, FL March 11-16th (2012).
67. K. Brinkman, J. Marra, A. Billings, K. Fox, M. Tang and K. Sickafus “The development of crystalline ceramic waste forms for an advanced nuclear fuel cycle” TMS 2011 Annual Meeting & Exhibition, San Diego, CA, February 27 - March 3, (2011).
68. K. Brinkman, K. Huang, F. Chen, D. Sholl, “Structure/Property Relations in Proton Conducting Ceramics of the Form $\text{SrCe}_{0.95}\text{Yb}_{0.05}\text{O}_3$ With Applications in Membrane Separations: The Role of Microstructure and Second Phase Additions to Enhance Electronic Conductivity” TMS 2011 Annual Meeting & Exhibition San Diego, CA, February 27 - March 3, (2011).
69. M. Tang, A. Kosoy-Simakov, M. Zhou, J. Valdez, G. Jarvinen, K. Sickafus, J. Crum, L. Turo, K. Fox, A. Billings, K. Brinkman, J. Marra, “Irradiation Damage Effects in Glass Ceramics for Advanced Waste Form Development” American Ceramic Society (ACERS) 35th International Conference & Exposition on Advanced Ceramics & Composites , Daytona Beach Florida January (2011).
70. A.E. Mendez Torres, K. Brinkman, D. Krementz, G. Weeks, K.C. Mandal “Surface Functionalization of Insulating Ceramics by Conductive Thin Film Deposition” Institute of Nuclear Materials Management (INMM) 52nd Annual Meeting, Palm Desert, California (2011).

71. J. Romero, H. Smart, D. Zamora, B. Schoemenan, T. Weber, K. Brinkman, D. Krementz, G. Weeks, A. Mendez Torres, "Intrinsically Tamper Indicating Ceramic Seal (ITICS)" Institute of Nuclear Materials Management (INMM) 52nd Annual Meeting, Palm Desert, California (2011).
72. A. Mendez Torres, K. Brinkman, G. Weeks, D. Krementz, "Synthesis and Characterization of Smart Functional Coatings by Chemical Solution Deposition Methods" Institute of Nuclear Materials Management (INMM) 52nd Annual Meeting, Palm Desert, California (2011).
73. R. Krishna, T. Hayes, A. Mendez Torres, K. Brinkman, K. Mandal, "Investigation of transparent conducting oxide thin films deposited on insulating ceramic materials" Materials Research Society (MRS) Spring Meeting, San Francisco CA April (2011).
74. D. Anton, W. James, J. Gray and K. Brinkman, AIChE Annual Meeting, "Environmental Reactivity of Solid-State Hydrogen Storage Systems: Fundamental Testing and Evaluation", Nov 7-12, Salt Lake City Utah (2010).
75. K. Brinkman, A. Billings, K. Fox, J. Marra, M. Tang and K. Sickafus "Alternative Waste Forms – Crystalline Ceramics via Multiple Fabrication Processes and Processes" FCR&D Separations/Waste Forms Working Group Washington DC Annual Review August 31, (2010).
76. C. Crawford, K. Brinkman, A. Billings, K. Fox, J. Marra, M. Tang and K. Sickafus, B. Ebert, J. Ryan, J. Vienna, "Overview of Research on Glass and Ceramic Wasteforms for Fuel Cycle Research and Development" American Nuclear Society, Las Vegas November (2010).
77. J. Marra, K. Brinkman, A. Billings, K. Fox, J. Marra, M. Tang and K. Sickafus "Overview of Research on Glass and Ceramic" Development of Ceramic Waste Forms for an Advanced Nuclear Fuel Cycle" Materials Science and Technology (MS&T) Annual Meeting Houston, October (2010).
78. K. Brinkman, R. Lascola, F. Chen, K. Huang, D. Sholl, "Structure/property relations in spark plasma versus conventionally sintered proton conducting ceramics of the form $\text{SrCe}_{0.95}\text{Yb}_{0.05}\text{O}_3$ with applications in membrane separations" Pacific Chemistry 2010, Honolulu HI December, (2010). **Pacificchem Young Scientist Award**
79. K. Brinkman, F. Chen, "Ionic Membrane Systems" Gordon Conference Membranes, New London, NH July (2010).
80. K. Brinkman, G. Morgan, C. Yeager, "Integrated System Strategies for Bio-Hydrogen Purification" at the Spring National ACS meeting in San Francisco, CA from March, (2010).

81. S. Garrison, K. Brinkman, P. Korinko, T. Adams, "DFT Modeling of Bulk Metallic Glass Membranes for H₂ Separation/Purification" North American Membrane Society (NAMS), Charleston SC, June (2009).
82. J. Gray, D. Anton, C. James, K. Brinkman, "Environmental Reactivity of Solid State Hydride Materials: Testing of 2LiBH₄·MgH₂ for Air and Water Exposure" Congress Palace Ajaccio - Corsica, France September 16-18, (2009).
83. C. James, D. Anton, J. Gray, B. Hardy, K. Brinkman "Modeling of LiBH₄+MgH₂ Hydrogen Storage System Accident Scenarios Using Empirical and Theoretical Thermodynamics" Congress Palace Ajaccio- Corsica, France September 16-18, (2009).
84. J. Gray, D. Anton, C. James, K. Brinkman, "Environmental Reactivity of Solid State Hydride Materials" DOE Annual Merit Review, Washington DC May (2009).
85. K. Brinkman, E. Fox, P. Korinko, T. Adams, "Hydrogen Permeation in Bulk Amorphous Glass Materials Systems" DOE Annual Merit Review, Washington DC May (2009).
86. T. Motyka, B. Hardy, K. Brinkman, D. Anton, "HSCoE Engineering Center of Excellence Technical Task Plans" DOE Annual Merit Review, Washington DC May (2009).
87. S. Garrison, K. Brinkman, P. Korinko, T. Adams, "Modeling of Bulk Metallic Glass Membranes for H₂ Separation/Purification" AIChE National Meeting, Nashville TN, Nov (2009).
88. K. Brinkman, E. Fox, P. Korinko, A. Jurgensen, T. Adams, "The Effects of Partial Crystallinity on the Hydrogen Permeation Properties of Bulk Amorphous Metallic Glass Systems" in TMS San Francisco "bulk metallic glasses symposium" February 15-21, (2009).
89. K. Brinkman, E. Fox, P. Korinko, T. Adams, "Thermodynamics and Kinetics of Devitrification: The Impact on the Hydrogen Permeation Properties of Metallic Glass Materials" National Hydrogen Association (NHA) Conference and Hydrogen Expo, Columbia SC March 30th-April 3rd (2009).
90. D. Anton, K. Brinkman, J. Gray, B. Hardy, "Hydride Environmental Reactivity", LANL-AIST Joint Fuel Cell & Hydrogen Storage Workshop, San Diego, CA, September 9-12, (2008).
91. K. Brinkman, T. Iijima, H. Takamura, "Preparation and Oxygen Permeation Properties of Nano-Crystalline CeO₂ Thin Films on Porous ceramic Substrates", Gordon Conference on Solid State Studies in Ceramics, Andover NH August (2008).
92. D. Anton, K. Brinkman, J. Gray, B. Hardy, "Environmental Reactivity in Solid State Hydrides", Freedom Car Tech Team Review Meeting, Detroit MI, August (2008).

93. D. Anton, K. Brinkman, J. Gray, B. Hardy, "Environmental Reactivity the $2\text{LiBH}_4\text{:MgH}_2$ system International Conference on Metal Hydrogen Systems", Reykjavik, Iceland May (2008).
94. J. Gray, K. Brinkman, B. Hardy, D. Anton, "Environmental Reactivity of Solid State Hydride Materials: Standardized Testing of $2\text{LiBH}_4\text{:MgH}_2$ for Air and Water Exposure" Materials Research Society (MRS) Spring Meeting, Hydrogen Economy Symposium, March (2008).
95. D. Anton, K. Brinkman, J. Gray, "Fundamental Safety Testing and Analysis of Hydrogen Storage Materials and Systems", Hydrogen Storage Tech Team Review, Gaithersburg, MD, September (2007).
96. D. Anton, K. Brinkman, J. Gray, "Fundamental Safety Testing and Analysis of Hydrogen Storage Materials to Environmental Exposure Scenarios" International Energy Agency (IEA), Amsterdam Netherlands (2007).
97. K. Brinkman, T. Iijima, H. Takamura, "BiFeO₃ ceramics as mixed conducting oxygen permeation membranes" Materials Research Society (MRS) Fall meeting, Solid State Ionics Symposium Dec (2006).
98. K. Brinkman, T. Iijima, K. Nishida, T. Katoda, H. Funakubo, "The Influence of Acceptor Doping on the Structure and Electrical Properties of Sol-Gel Derived BiFeO₃ Thin Films" The 5th Asian Meeting on Ferroelectrics, Tokyo University of Science Noda Campus, Tokyo, Japan September 3-7, (2006).
99. K. Brinkman, A. Tagantsev, P. Muralt, N. Setter, "Self-Polarization in PST thin films: Impact on the Dielectric and Piezoelectric Response" Japanese Meeting on Ferroelectrics (FMA), Kyoto Japan May (2006).
100. S. Osone, K. Brinkman, T. Iijima, "Composition dependence of d_{33} for $\text{PbZr}_x\text{Ti}_{1-x}\text{O}_3$ thick films" Japanese Applied Physics Society Conference, Tokyo Japan March (2006).
101. S. Osone, K. Brinkman, T. Iijima, "In-situ X-ray diffraction studies of electric field induced 90 degree domain rotation in $\text{PbZr}_{0.3}\text{Ti}_{0.7}\text{O}_3$ thick films" Japanese Applied Physics Society Conference, Tokyo Japan, March (2006).
102. S. Kamba, V. Bovtun, J. Hlinka, J. Petzelt, K. Brinkman, N. Setter, M. Tyunina, J. Levoska, "Infrared and submillimeter dielectric response of relaxor ferroelectrics" Workshop on Tunable Ferroelectrics, Chateaux D'Oex, Switzerland February (2006).
103. K. Brinkman, A. Tagantsev, N. Setter, "The Impact of Chemical Ordering on the Dielectric Response of PST Relaxor Thin Films" COST 525 Dielectric and Semiconductor section, Limerick, Ireland, November (2004).

104. K. Brinkman, D. Su. A. Tagantsev, N. Setter, “A Study on the Impact of Chemical Ordering on the Dielectric Properties of PST Thin Films” European Physical Society: Condensed Matter Division conference, Prague, Czech Republic, July (2004).
105. S. Kamba, V. Bovtun, J. Hlinka, J. Petzelt, K. Brinkman, N. Setter, “THz phonon response of PMN relaxor Thin Films” European Physical Society: Condensed Matter Division conference, Prague, Czech Republic, July (2004).
106. K. Brinkman, M. Cantoni, A. Tagantsev, P. Muralt, N. Setter, “Dielectric Response and Structural Features of PST Sol-Gel Derived Thin Films” International Conference on Electroceramics (ICE), MIT Cambridge, Massachusetts August (2003).
107. K. Brinkman, M. Cantoni, N. Setter, “Sol-Gel Processing of PST thin films” COST 525 Dielectric and Semiconductor Section, Genoa, Italy, May (2002).
108. K. Brinkman, N. Setter, “Processing of PST relaxor thin films” 3rd KAIST-EPFL conference on relaxor ferroelectrics, Lausanne Switzerland August (2001).
109. W. Nothwang, K. Brinkman, R. Schwartz, “Understanding the Performance of THUNDER Actuators: The Role of Stress and Device Mechanics” Processing of Fibers and Composites Conference, Chair: K.K. Chawla (Univ. of Alabama Birmingham) Castelvechio Pascoli, Italy, May (2000).

INVITED PRESENTATIONS (*62 invited presentations*)

1. K. Brinkman, “Electrical, structural, and thermodynamic analysis of materials for additive manufacturing of electrochemical devices” Symposium I07: Advanced Manufacturing for High-Temperature Materials and Devices, Electrochemical Society (ECS), Montreal, Canada May 21 2025.
2. K. Brinkman, Crystalline Ceramic Materials: From Immobilization of Nuclear Waste Improved Batteries and Fuel Cells, Georgia Tech, Department of Materials Science and Engineering Seminar March (2025)
3. K. Brinkman, Structural and thermodynamic analysis of BaCo_{0.4}Fe_{0.4}Zr_{0.2}-XYXO_{3-δ} triple conducting electrode materials for protonic ceramic fuel cells, 14th International Conference on Ceramic Materials and Components for Energy and Environmental Systems CMEEC14, Budapest Hungary August (2024)
4. K. Brinkman, Crystalline Perspectives on Ceramics: From Immobilization of Nuclear Waste to Improved Batteries and Fuel Cells, University of Connecticut Department of Materials Science and Engineering Seminar September (2024)

5. K. Brinkman, Crystalline Ceramic Materials: From Immobilization of Nuclear Waste Improved Batteries and Fuel Cells, Carnegie Mellon University, Department of Materials Science and Engineering Seminar January (2024)
6. C. Dandeneau, B. Garcia-Diaz, K. Brinkman, "Solid Electrolyte Development for Direct LiT Electrolysis in Molten Li Mixtures" 48th International Conference of Advanced Ceramics and Composites ACERS, Jan 28-Feb 2, 2024 Daytona Beach FL
7. K. Brinkman, MRS 2023 – 47th Scientific Basis for Nuclear Waste Management (SBNWM), "A site occupancy effects on structure and thermochemistry in tunnel structured $K_xMg_{x/2}Ti_{8-x/2}O_{16}$ ($0 < x < 2$) hollandites" Cologne, Germany November 2023.
8. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of Hannover, Germany, -Chemistry Seminar, November (2023).
9. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of Cologne, Germany- Chemistry Seminar, November (2023).
10. K. Brinkman, Scalable Manufacturing of Garnet Structured LLZO Ceramic Tubes with Application in Next Generation Fusion Systems in Ceramics for New Generation Nuclear Energy Systems, Materials Science and Technology (MS&T) Columbus OH, October 2, (2023).
11. K. Brinkman, **ACerS Navrotsky Award Lecture** "Thermodynamic Stability, Radiation Damage and Leaching Effects in Tunnel Structured Hollandite Materials", Thermodynamics of Materials in Extreme Environments, Materials Science and Technology (MS&T) Columbus OH, October 3, (2023).
12. K. Brinkman, The Oxygen and Proton Kinetics of BCFZY Triple Conducting Electrode Materials for Protonic Ceramic Fuel Cells" Conference and Exhibition of the European Ceramic Society (ECeRs) Lyon, France July (2023)
13. K. Brinkman, "Nanostructured Ceramic Membranes for Hydrogen Isotope Processing" EN08: Scientific Basis for Nuclear Waste Management, Materials Research Society MRS Boston, MA December (2022)
14. K. Brinkman, "A Department Chair Perspective on the Faculty Search Process" ACerS/TMS Emerging Faculty Symposium : Faculty Life and Collaborations, Materials Science and Technology (MST 2022) Pittsburgh PA, October (2022).
15. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of North Carolina Charlotte (UNCC), ME Seminar, September (2023).
16. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of Alabama, MSE Seminar, September (2023).

17. K. Brinkman, "Surface and Bulk Oxygen Kinetics of BCFZY Triple Conducting Electrode Materials" Solid State Ionics, "Energy and Fuels Conversion" Symposium of Solid State Ionics (SSI-23), Boston MA July (2022).
18. K. Brinkman, "Thermodynamic stability, radiation damage and leaching effects in tunnel structured hollandite materials" 9th Forum on New Materials Focused Session FR-10, Materials Issues in Radioactive Nuclear Waste Treatment and Disposal, CIMTEC 2022, Perugia, Italy, June (2022).
19. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of Naples, Italy MSE Seminar, June (2022).
20. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" West Virginia University ME Seminar, April (2022).
21. Kyle Brinkman, "Interdisciplinary Concepts in Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of Virginia, MSE Seminar, September (2021).
22. Kyle Brinkman, "Energy Materials: From Nuclear Waste to Improved Batteries and Fuel Cells" University of Michigan, MSE Seminar, April (2021).
23. Kyle Brinkman, "Insights into the surface exchange kinetics of proton conducting ceramics" Electronic Materials and Applications Virtual 2021 (EMA2021) Symposium 9: Ion-conducting Ceramics Session title: Ionic Conducting Materials for Energy Conversion and Storage: Synthesis, Processing, and Theoretical Studies Jan 20th, 2021.
24. Kyle Brinkman, "Interdisciplinary Concepts in Ceramic Based Energy Materials: From Nuclear Waste to Fuel Cells" University of Central Florida, MSE Distinguished Seminar Series, October 30th, (2020).
25. Kyle Brinkman, Protonic Ceramic Fuel Cells: Materials and Device Development in Symposium Advanced Materials for Energy Conversion and Storage VI at the the Minerals, Metals and Materials Society (TMS) Annual Meeting in San Diego, CA, February (2020).
26. Kyle Brinkman, "Recent Progress in Low-Temperature Proton Conducting Ceramics for Hydrogen Isotope Processing" 236th Electrochemical Society (ECS) Meeting, Atlanta, GA October (2019).
27. K. Brinkman, Radiation Tolerant Ceramics for Nuclear Waste Immobilization: Structure and Stability of Zinc Substituted Hollandites with High Cesium Loading, Symposium Structure–Property Processing Performance Relationships in Materials for Nuclear Technologies at the Materials Research Society Fall Meeting (MRS) Boston, MA (2019).

28. Kyle Brinkman, “Protonic Ceramic Fuel Cells: Materials and Device Development” at the University College of London, Institute Materials Discovery, July (2019).
29. Kyle Brinkman, “Clemson University Department of Materials Science and Engineering: Distinguished History, Exceptional Future, Savannah River National Laboratory (SRNL) Lab Directors Colloquium Series December (2019).
30. Kyle Brinkman, “Framework dopant effects in tunnel-structured hollandite waste forms for Cs-immobilization” Session: PHYS: New Frontiers in the Confluence of Experimental Thermodynamics, Structural Investigations & Theory/Computation ACS National Meeting, Orlando FL March (2019).
31. Kyle Brinkman, “Interfacial Control of Mixed Ionic and Electronic Conduction (MIEC) in Ceramic Composites for Energy Conversion and Storage” Session CJ-5 Fast ion-conducting ceramics of Symposium CJ "Advances in Electroceramics: Processing, Structure, Properties, and Applications" of the Ceramics Congress CIMTEC Perugia Italy June, (2018).
32. Kyle Brinkman, Mingyang Zhao, Jake Amoroso, Kristina Lilova and Alex Navrotsky “Compositional control of radionuclide retention in hollandite-structured ceramic waste forms for Cs-immobilization” Session 06g: Energy landscapes in biomineralization, geochemistry, and materials science: a celebration of Alex Navrotsky’s 75th birthday at Goldschmidt Geochemical Society Annual Meeting, Boston MA August (2018).
33. K Brinkman, “Interdisciplinary View of Interfaces: Perspectives Regarding Emergent Phase Formation” University of Connecticut ME/MSE Colloquium Series, April (2018).
34. K. Brinkman, “Interfacial Control of Ceramics in Clean Energy” University of Texas Arlington, Predictive Performance and Methodologies Institute, Arlington, TX, November 10th, (2017).
35. K. Brinkman, “Advanced Characterization of Model Multiphase Ceramic Waste Forms” Symposium: Materials Issues in Nuclear Waste Management at Materials Science and Technology (MS&T), Pittsburgh PA Oct 8-12th (2017).
36. K. Brinkman, “Structural Evolution and Thermodynamics in Hollandite Solid Solutions for Nuclear Waste Immobilization and Implications for Solid State Battery Materials” Thermodynamics Consortium Workshop, University of California at Davis, June 27th (2017).
37. K. Brinkman, “Interfacial Control of Ceramic Composites in Clean Energy”, Sandia National Laboratory, Livermore CA June 26th, (2017).

38. Kyle Brinkman, “CFA-14-6357: A New Paradigm for Understanding Multiphase Ceramic Waste Form Performance” Department of Energy, Nuclear Energy Campaign Meeting, Albuquerque, February 13th, (2017).
39. Kyle Brinkman, “Interfacial Control of Ceramic Composites in Energy Conversion and Storage Applications” Tohoku University, Department of Materials Science and Engineering Colloquium, Sendai Japan December 8th, (2016).
40. Kyle Brinkman, “Interfacial Control of Ceramic Composites in Energy Conversion and Storage Applications” National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba Japan December 6th, (2016).
41. Kyle Brinkman, “Interfacial Control of Ceramic Composites in Energy Conversion and Storage Applications” Nagoya University, Department of Nuclear Engineering, Nagoya Japan, December 9th, (2016).
42. Kyle Brinkman, “Ceramic Composites in Diverse Applications Ranging from Oxygen Production to Nuclear Waste Immobilization” in Nanocomposites IV: Nanoscience for Renewable Energy symposium at the Minerals, Metals and Materials Society (TMS) Annual Meeting in San Diego, CA February 27th, (2017).
43. Kyle Brinkman, Composite Materials in Nuclear Energy: Multiphase Ceramic Waste Forms” Duracosys 2016 12th Annual Conference on Durability of Composite Systems, University at Texas at Arlington, June 12-15, (2016). **Keynote**
44. Kyle Brinkman, “Waste in Society- A Role for Ceramics?” Materials Summit, Villars sur-Ollon, Switzerland, September 27-29th, (2016).
45. Kyle Brinkman, “Interfacial Control of Ceramic Composites in Energy Conversion and Storage Applications” Forschungszentrum Jülich, September 22nd, (2016).
46. Kyle Brinkman, “The Role of Ionic Transport in Cs containing Hollandites for Nuclear Waste Immobilization” in symposium IO5 Heterogeneous Functional Materials for Energy Conversion and Storage at the 229th Electrochemical Society (ECS) Meeting, San Diego, CA, May 30th, (2016).
47. Kyle Brinkman, “The Role of Ionic Transport in Nuclear Waste Immobilization and Membrane Separations” at the American Ceramic Society’s Electronic Materials and Applications (EMA), Orlando FL, January 21-23 (2016).
48. K. Brinkman, “Multiphase ceramic composites for energy conversion and storage” oral presentation at the 4rd International Symposium on Energy Challenges & Mechanics - Working on Small Scales (ISECM), Aberdeen, Scotland, August 10th (2015). **Keynote address**

49. Kyle Brinkman, "Multiphase Ceramic Composites for Membrane Separations and Nuclear Waste Immobilization- The Role of the Interface" the European Congress and Exhibition on Advanced Materials and Processes (EUROMAT Sept 20th-24th Warsaw, Poland (2015). **Keynote- TMS/FEMS Young Leader International Scholar Lecture**
50. Kyle Brinkman, "Enhancing Grain Boundary Ionic Conductivity in Mixed Ionic-Electronic Conductors" Ceramic Composites at Lake Louise, Banff, Canada, November 8th-12th, (2015).
51. Kyle Brinkman "Crystalline Ceramics for Nuclear Waste Immobilization and Membrane Separations" Institute of Materials, Ceramics Laboratory, Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland, September 17th, (2015).
52. Kyle Brinkman, "The Role of the Interface in Multiphase Ceramic Composites" North Carolina State, Materials Science and Engineering Department Fall 2015 Colloquium Series, September 4th, (2015).
53. Kyle Brinkman, "Multiphase Ceramic Composites - The Role of the Interface." Advanced Composite Materials Division Institute of Fundamental Technological Research of the Polish Academy of Sciences, Warsaw, Poland, September 25th, (2015).
54. Kyle Brinkman, "Multiphase Ceramic Composites - The Role of the Interface." Institute of Physics, University of Silesia, Katowice, Poland, September 28th, (2015).

Prior to Clemson

55. K. Brinkman, "Advanced Ceramic Waste Forms" delivered in symposium entitled "Progress in DOE's Fuel Cycle Research and Development Program (FCR&D)" at 2013 Winter American Nuclear Society Conference (ANS) in Washington DC November 10-14th, (2013).
56. K. Brinkman, "Ceramic Waste Form Development" DOE-ROSATOM 4th Technical Exchange Meeting, October 7th, Idaho Falls ID (2013).
57. K. Brinkman, "Advanced Materials in Energy Systems" Science Café in Columbia, SC July 9th, 2013. Keynote speech along with SC SmartState Chair Ken Reifsnider, advertised on SC-National Public Radio sponsored by Engenuity (<http://www.engenuitysc.com/sciencecafe>)
58. K. Brinkman, "Mixed Ionic and Electronic Membrane Systems: Interfacial Control and Modification of Material System Properties" Brookhaven National Laboratory (BNL)-National Synchrotron Light Source (NSLS-II) First Experiment Workshop August 13th, (2013).

59. K. Reifsnider, K. Brinkman, “Multiphysics Functional Design of HeteroFoam Nanomaterials for Energy Systems Energy” Nanomaterials Symposium at the 141st Annual TMS meeting in Orlando, FL March 11-16th (2012).
60. K. Brinkman, “Nanocrystalline Ceria Membranes for Gas Separation- Size Dependent Transport” in the Energy Conversion and Fuel Cells Symposium of the Materials Science and Technology (MS&T) Conference in October Columbus, OH (2011).
61. K. Brinkman, “Advanced Materials in Energy Systems: Enabling Technologies” Innoventure Spartanburg, SC July (2010). **Keynote**
62. K. Brinkman, M. Cantoni, A. Tagantsev, P. Muralt, N. Setter, “Comments on the Dielectric Response of Thin Film Relaxor Ferroelectrics” POSTEC, Pohang, South Korea, October (2003).

PATENTS (*6 patents issued, 5 disclosures patent pending*)

Issued

K. Brinkman, J. Amoroso, J. Tong, Nanostructured Ceramic Membranes for Hydrogen Isotope Processing” U.S. Patent No. US 12,410,072 B2, Sept 9th 2025.

D. Hitchcock, S. Serkiz, J. Velten, T. Krentz, Kyle S. Brinkman, Eric Vogel, K. Young, “Hydrogen Isotope Separation Methods and Systems” US Patent No. 11,433,353 2022

F Chen, S Fang, K Brinkman, S Wang, J He, Y Liu, US Patent Number 10,899,613 “Graphene-Ceramic Composite Membrane for Hydrogen Separation Membranes” 2021

S. Fang, F. Chen and K. Brinkman, US Patent Number: 61/995,149A “Novel Chemically Stable Ceramic-Metal Composite Membrane for Hydrogen Separation” 2019

K. Brinkman, E. Fox, P. Korinko, F. Chen, U.S. Patent Number: 13/066,166 “Proton Conducting Ceramics in Membrane Separations” 2015

K. Brinkman, U.S. Patent Number: 13/297,826 “Nanocrystalline Cerium Oxide Materials for Solid Fuel Cell Systems” 2015

Disclosures Submitted

J. Tong, H. Xiao, F. Peng, K. Brinkman, S. Mu, J. Lei, Y. Hong, H. Huang, Integrated additive manufacturing and laser processing systems and methods for ceramic, glass, and silicon carbide applications H Xiao, J Tong, F Peng, KS Brinkman, S Mu, LEI Jincheng, Y Hong, US Patent App. 17/138,173 January 13th, 2022

K. Brinkman, G. Garcia-Diaz, J. Gray, “Electrochemical Cell for Recovery of Metals from Solid Metal Oxides”, U.S. Provisional Patent Application Serial No. 14/449,783, Publication number US 2016/0032473 A1, February 4th, 2016.

K. Brinkman, B. Riley, M. Naguib, MXenes and their hybrids as Sorbent Materials for Off-gas Radioiodine Capture and Immobilization” CURF Tech Record ID #2023-044, 2023.

K. Brinkman, B. Garcia-Diaz, J. Tong, C. Dandeneau, D. Hitchcock, Tianyu Zhou, Rahul Rajeev, “SCALABLE 3D PRINTING AND REACTIVE SINTERING OF Li ION CONDUCTING GARNET STRUCTURED CERAMIC TUBES” CURF Tech Record ID #2023-040, 2023.

J. Tong and Kyle Brinkman, “Highly Compact Double-faced Flat-tubular Solid Oxide Cells Fabricated by Additive Manufacturing Technologies” CURF Tech Record ID #2024-032, 2024.

ENTREPRENEURSHIP

Companies Formed:

Energy Materials Consulting Company (EMC2) 2018-Present

X-ION ENERGY 2023-Present, Awarded \$1M from South Carolina Research Authority (SCRA)

<https://www.scra.org/get-support/get-startup-funding/sact-grant/clemson-university-sact-grant/>

Awards to Brinkman’s Students

Bishop and Robinson Fellowships 2019 (Mingyang Zhao and Jun Gao); Jun Gao awarded American Ceramic Society, Basic Science Division (BSD) GEM Award in 2019; Mingyang awarded ACERS Nuclear Environmental Technology Division NETD award in 2019

ACerS/ECerS travel scholarship for Mr. Mingyang Zhao to attend the European Ceramic Society’s (ECerS) Summer School in Hasselt, Belgium, July 6 and 7, 2018.

NEUP Undergraduate Fellowship, Nicholas Hadden, 2015-2016

Nuclear Engineering and Radiological Sciences Scholarship from the Nuclear Regulatory Commission (NRC), Devin Williams, 2016

Seaborg Institute Graduate Student Fellowship at the Department of Energy’s Los Alamos National Laboratory (LANL), Rob Grote, 2016

Donovan Moses, Title IX Fellow and CECAS Deans Fellow 2021; ACERS PCSA 2022

EXTERNAL SPONSORED RESEARCH

Since 2014 at Clemson >\$49M in total awards with >\$9.8 M million directly attributable to funded research in group

Highly Compact Double Faced Flat Tubular Protonic Ceramic Cells for Mobile Applications, South Carolina Research Authority (SCRA) Lab to Market Award, co-PI \$860,000 (\$430,000) (2024-2027)

NSF MRI: Track 1 Acquisition of 500MHz Solid State NMR Spectrometer for Research and Education, co-PI \$1,000,000 (\$100,000) (2024-2027)

Non-Aqueous 2D Material Based Hydrogen Isotope Separation, DOE Fusion Energy through SRNL, co-PI \$1,000,000 (\$300,000) (2025-2027)

Effect of Multiple Uranium Complexes on Chloride Fast Reactor Molten Properties, DOE- Nuclear Energy University Programs co-PI \$1,000,000 (\$300,000) (2023)

MXene as Sorbent Materials for Off-gas Radioiodine Capture and Immobilization, DOE- Nuclear Energy University Programs, PI \$1,000,000 (2023-2026)

SRNL Glass Database Sponsored by Savannah River National Laboratory SRNS/SRNL, PI \$115,520 (2022-2025)

High Temperature and Ultra High Temperature Ceramic Matrix Composite System Development SOW1 Air Force/GE Aviation: co-PI \$7,079,449 (707,000) (2022-2028)

Redox Cycles of Novel High-Entropy Perovskite Oxides for Clean Fuel Production through Solar Thermochemical Water and Carbon Dioxide Splitting, DOE EPSCOR, co-PI \$750,000 (\$187,500) (2022)

VIPR-GS - SimBRS II TO012: Virtual Prototyping of Autonomy-Enabled Ground Systems Project FA2.2, Protonic Fuel Cell Propulsion Systems co-PI \$500,000 (\$100,000) (2021)

Phosphate Mineral and Glass Waste Forms for Advanced Immobilization of Chloride- and Fluoride-based Waste Stream, DOE- Nuclear Energy University Programs PI \$600,000 (\$600,000) (2021)

Protonic fuel cell and electrocatalysts materials synthesis and characterization, Sponsored by Idaho National Laboratory INL, PI \$104,000 (2021)

Process Intensification Scale-Up of Direct Lit Electrolysis, Department of Energy Advanced Research Projects Agency-Energy (ARPA-E), PI \$500,000 (2021)

High-Speed TGA for Thermodynamic and Kinetic Study of Nuclear Energy Materials, DOE- Nuclear Energy University Programs, co-PI \$228,237 (\$27,388) (2020)

IRES: Track 1: Self-Healable Materials Development (Urban), National Science Foundation (NSF), co-PI \$299,995 (\$45,000) (2020)

Rapid Laser 3D Printing of Reversible Solid Oxide Electrochemical Cell Stacks for Producing Pure O₂ from CO₂ and Storing Electricity into Carbon, NASA EPSCOR, co-PI \$750,000 (\$300,000) (2020)

Optimizing Melt Processed Phosphate Glass Waste Forms via Composition-Property-Structure Correlations, DOE- Nuclear Energy University Programs PI \$400,000 (\$400,000) (2020)

Renewal: Center for Hierarchical Waste Form Materials, DOE Basic Energy Sciences Energy Frontier Research Center (EFRC), co-PI, \$11,200,000 (\$950,000), (2020-2024)

Electrocatalytically Upgrading Methane to Benzene in a Highly Compacted Microchannel Protonic Ceramic Membrane Reactor, DOE-National Energy Technology Lab (NETL), co-PI \$1,000,000 (\$200,000) (2020)

Solid State Ionics Advanced Manufacturing Sponsored by Savannah River National Laboratory SRNS/SRNL, PI \$186,000 (2019)

Laser 3D Printing of Highly Compacted Protonic Ceramic Electrolyzer Stack, Sponsored by DOE EERE, co-PI \$1,600,000 (\$320,000) (2019)

Synthesis and Characterization of Solid Proton Conductors and Conductivity Measurements Sponsored by SRNS/SRNL, PI \$20,000 (2018)

In-situ Measurement and Validation of Uranium Molten Salt Properties at Operationally Relevant Temperatures, DOE- Nuclear Energy University Programs, co-PI \$800,000 (\$180,000), (2017)

Fabricating Uranium Mononitride Powder and Microsphere using Sol-Gel Processing - Sponsored by BWX Technology, co-PI \$195,945 (\$33,310) (2017)

Renewal: Radionuclide Waste Disposal: Development of Multi-scale Experimental and Modeling Capabilities, Department of Energy EPSCoR (Powell), co-PI \$ 2,023,000 (\$222,000) (2017)

Precision Solution Calorimeter for Advanced Thermodynamic Characterization, CU MRI Grant, PI \$57,000 (2017)

Nanostructured Ceramic Membranes for Enhanced Tritium Management, DOE- Nuclear Energy University Programs, PI \$800,000 (\$400,000), (2017)

High-Temperature Atmosphere-Controlled Raman Microscope for Fuel Cycle Materials Research, co-PI \$250,000 (\$80,000) (2017)

Materials Development of Ceramic Li-Ion Conductors for Direct LiT Electrolysis, Office of Science Fusion Energy, PI \$210,000 contract to Clemson from SRNS/SRNL (2017)

Center for Hierarchical Waste Form Materials, DOE Basic Energy Sciences Energy Frontier Research Center (EFRC), co-PI, \$8,000,000 (\$310,000), (2016-2020)

Fabricating Sol-Gel Precursors for RareEarth Metal Oxide Doped UO₂ Nuclear Fuel 1, co-PI \$36,995 (\$10,000) from BWX Technology (Industry) (2017)

3-D Structured Protonic Ceramic Membranes for Electrochemical Hydrogen Compression, co-PI \$50,000 (\$25,000) Purchase Order through MSE by Grover Coors of CoorsTek (2017)

Oxygen Separation from Air to Provide Supplemental Oxygen for Injured Soldiers through DOD-SBIR Phase I in collaboration with Nanowise LLC PI \$45,000 (2015)

High Temperature Melt Solution Calorimeter: The Thermodynamic Characterization of Oxides in Nuclear Energy, DOE-Nuclear Energy University Programs, General Scientific Infrastructure Support, PI (\$325,000) (2015)

A New Paradigm for Understanding Multiphase Ceramic Waste Form Performance, DOE-Nuclear Energy University Programs, PI \$800,000 (\$400,000), (2014)

Ceramic Composite Synthesis and Characterization (HeteroFoaM EFRC), SRNS through SCUREF, PI \$45,000 (2014)

Ceramic Composite Synthesis and Characterization (FCR&D Waste Forms), SRNS through SCUREF, PI \$150,000 (2014-2017)

Materials and Processes for Efficient Natural Gas Utilization, TIGER Clemson Grant, PI \$20,000 (2014)

Radionuclide Waste Disposal: Development of Multi-scale Experimental and Modeling Capabilities, Department of Energy EPSCoR, co-PI \$ 5,250,000 (\$300,000) (2014)

Torque Sensitive Washers, BMW, co-PI \$150,000 (\$75,000) (2015)

Prior to Clemson

Nanocrystalline Proton Conducting Ceramics for Hydrogen Separation Membrane Applications, SRNL Laboratory Directed Research and Development (LDRD), PI \$150,000 (\$150,000), (2008)

Metal Hydride Based Thermoelectric Device, SRNL Laboratory Directed Research and Development (LDRD), co-PI \$150,000 (\$75,000), (2008)

Interaction of Hydrogen with Bulk Amorphous Microstructures in Metallic Systems: The Fundamental Influence of Materials Chemistry, SRNL Laboratory Directed Research and Development (LDRD), co-PI, \$150,000 (\$75,000), (2008)

Physics Based Nano-Structure Design and Synthesis of Heterogeneous Functional Material for Energy Systems HeteroFoaM, DOE-Basic Energy Sciences Energy Frontier Research Center, co-PI, \$12,000,000 (\$470,000), (2009-2014)

Integrated System Strategies for Bio-Hydrogen Purification, SRNL Laboratory Directed Research and Development (LDRD) Quick Hit, PI, \$50,000 (\$30,000), (2009)

Nanocrystalline Proton Conducting Ceramics, Phase 2, SRNL Laboratory Directed Research and Development (LDRD), PI, \$200,000 (\$200,000), (2009)

Crystalline Waste Forms for an Advanced Nuclear Fuel Cycle, DOE-Nuclear Energy, PI, \$1,300,000 (\$700,000), (2009-2013)

Tritium Sequestration in Gen IV NGNP Gas Stream via Proton Conducting Ceramic Pumps, DOE-Nuclear Energy University Programs (NEUP), co-PI, \$500,000 (\$100,000) (2009-2011)

Highly Tritiated Water Processing, International Fusion Project ITER, co-PI, \$300,000 (\$75,000), (2010)

Novel Methods of Tritium Sequestration: High Temperature Gettering and Separation Membrane Materials Discovery for Nuclear Energy Systems, DOE-Nuclear Energy University Programs (NEUP), co-PI, \$1,300,000 (\$270,00), (2010-2013)

Ceramic Seals for Tamper Indication in Nuclear Safeguards Applications, DOE-NNSA-National Nuclear Security Administration-NA22, co-PI, \$900,000 (\$200,000) (2010-2012)

Heterogeneous Materials and Novel Interfaces for Oxygen Separation Membranes SRNL Laboratory Directed Research and Development (LDRD), PI, \$200,000 (\$120,000) (2011)

Melt Processed Crystalline Ceramic Waste Forms for Advanced Nuclear Fuel Cycles, Coordinated Research Agreement No. 17208/R0 from the International Atomic Energy Agency (IAEA), PI, \$15,000 (\$5,000) (2012-2015) *travel grant for annual meetings in Vienna and participation in reports issued by the agency.*

Solid Oxide Reduction of Used Nuclear Fuel, SRNL Laboratory Directed Research and Development (LDRD), PI, \$250,000 (\$125,000), (2013)

High Temperature Membranes for Natural Gas Conversion, SRNL Strategic Initiative, PI, \$300,000 (\$200,000), (2013-2014)

Crystalline Ceramic Waste Forms for Advanced Fuel Cycle, DOE-Nuclear Energy University Programs (NEUP), co-PI, \$800,000 (\$160,000), (2012-2015)

GRADUATE STUDENT ADVISING

Doctoral Graduates

Robert Grote (Ph.D.) December 2018
Jun Gao (Ph.D.) May 2021
Mingyang Zhao (Ph.,D.), May 2021
Changlong Li (Ph.D.), August 2021
Jack Duffy (Ph.D.), December 2023

Masters Graduates

Devin Harkin (M.S.) Graduated Dec 2016
Changlong Li (M.S.) Graduated August 2016
Katherine Bolek (M.S.) Graduated August 2020
Adam Gootgeld (M.S.) Graduated August 2023
Nathan Creteigny (M.S.) Graduated May 2024

Prior to Clemson

Lingling Zhang (Ph.D.) “Dual-Phase Mixed Ion Conducting CO₂-Selective Permeation Membranes” University of South Carolina, October 2013, (Committee)
Siwei Wang (Ph.D.) “Preparation, Characterization and Application of Novel Proton Conducting Ceramics” University of South Carolina, June 2013, (Committee)
William Rigdon (Ph.D.) “Durability and Performance of Electrodes Designed with Carbon Nanotube Composite Catalysts for Polymer Electrolyte Membrane Fuel Cells” University of South Carolina, Fall 2014 (Committee)
Fazle Rabbi (Ph.D.) “Heterogeneous behavior study of Mixed Ionic-Electronic Conducting (MIEC) membranes using Broadband Dielectric Spectroscopy (BbDS)” University of South Carolina, Fall 2014 (Committee)
Yu Chen (Ph.D.) “Fabrication and Characterization of Novel Electrodes for Solid Oxide Fuel Cell for Efficient Energy Conversion”, Fall 2014 (Committee)

Current Graduate Advising

Rahul Rajeev (Ph.D.) 2026
Nakeshma Cassell (Ph.D.) 2026
Peyton McGuire (Ph.D.) 2026
Joshua Willoughby (Ph.D.) 2027

Post Doctoral Research Advisees

Alumni

Abhya Mishra, “Electrochemistry in Batteries and Fuel Cells” 2022-2025
Nancy Birker, Thermodynamics “Research Assistant Professor” 2018-2024
Shraddha Jadhav, Synthesis of Oxides for Energy, 2021-2023, currently postdoc Chemistry department
Yuqing Meng, “Proton Conducting Fuel Cells Materials Development” 2017-2022.
Currently staff scientist Department of Energy Idaho National Laboratory
Chris Dandeneau, “Materials Synthesis and Surface Science” 2020-2021
Akihiro Iishi, “Additive Manufacturing of Ceramics” 2019-2020
Ye Lin, Research Assistant Professor (2016)

Cong Ren, "Oxygen Separation Membranes and SOFC systems"
(2015-2016)
Tao Hong, "Ceramic Composites for Nuclear Waste Immobilization and Surface
Exchange Reactions"
(2015-2017)
Sayful Islam, "Torque Sensitive Washers- BMW Industrial Project" co-advised (2015-
2016)
Siwei Wang, "Interfacial Characterization of Ionic Conducting Ceramic Membranes"
(2014-2015)
Yun Xu, "Local Structure Characterization of Crystalline Ceramic Waste Form Systems"
(2014-2017)

TEACHING

Courses Taught

MSE 2410, Metrics Laboratory, F15
MSE 2100, Introduction to Materials Science and Engineering, F14, S16, F18
MSE 8000/8010, Graduate Student Seminar, F14, S15, F16, S17
MSE 4160, Electrical Properties of Materials, S15, S16, S17, S18, S23
MSE 4570 Honors Research, S19, F19, S10, F20, S21, F21, S22, F22, S23, F23
MSE 8900, Special Topics, Materials for Energy conversion and Storage, F17

Co-teaching:

MSE 8100, Introduction to Materials Science and Engineering, F15 (weeklong series of
lectures on defects, conduction and applications part of graduate introduction to Materials
led by Dr. Bordia and Dr. Luzinov)
CH 8130, Electrochemical Science, S15 (delivered weeklong series of lectures on high
temperature electrochemistry for course taught and led by Dr. S. Creager in Chemistry)
MSE 8000/8010, Graduate Student Seminar, F14, S15
EES 4120 Nuclear Fuel Cycle and Radioactive Waste Management, Lindsay Shuller
Nickles Nuclear Class, F16

Prior to Clemson

Advanced Ceramics, Materials Course to New Engineers at the Savannah River Site,
2009, 2010, 2011
ME-791 at USC, Dense Membranes for Gas Separation: Theory and Applications, S11

Courses Developed

ME-791 at USC, Dense Membranes for Gas Separation: Theory and Applications, S11
MSE 8900, Special Topics, Materials for Energy conversion and Storage, F17

UNIVERSITY AND PUBLIC SERVICE

University Committee

College of Engineering, Computing and Applied Sciences representative on the
Research Grants Committee, Member (2016-2019)

College Committee

Undergraduate Curriculum Committee, member (2014-2015)
Search Committee Associate Dean Research College Engineering (2016)

Department Committee

Graduate Standard Committee, Chair (2016-18)
Undergraduate Committee, Chair (2014-2015), member (2015-2016)
Search and Screen Committee New Faculty Hires, Member (2016 -2017)
Search and Screen Committee, SmartState/Sirrine Endowed Chair (2015-2016)
Search and Screen Committee New Faculty Hires, Member (2014 -2015)

Other Service

Co-Director, Nuclear Environmental Engineering Sciences and Radioactive Waste Management (NEESRWM) (2018-present)
Clemson technical co-lead as appointed by VPR to Battelle Savannah River Alliance (BSRA) proposal team which now managed Department of Energy's Savannah River National Laboratory (SRNL). <https://news.clemson.edu/department-of-energy-selects-battelle-savannah-river-alliance-for-3-8-billion-contract-to-manage-savannah-river-national-laboratory-with-clemson-university/>
Chair of the "Future Materials" Thrust Committee appointed by the Provost as part of Clemson's Strategic Plan *Clemson Elevate*
Committee chair of the Advanced Materials Innovation Complex (AMIC) building development approved by Board of Trustees Fall 2021 and groundbreaking in 2023. <https://news.clemson.edu/presidents-update-board-of-trustees-recap-covid-updates-fall-break/>
Faculty Advisor, Materials Advantage, Undergraduate Student Chapter (2014 - 2018).
Faculty Advisor, Keramos (2014-2018).
ADRS Seminar Series, assisted in recruiting and hosting speakers. 2015-2016
Clemson Elementary teaching volunteer in classroom (~2hours per month) 2014-Present
Led Clemson Input to AIChE Rapid Processes Intensification NNMI proposal
Appointed by Clemson VPR to serve on Savannah River National Laboratory External Review Committee 2016
Associate Dean of Research ADR Search Committee 2019
International Presentation on Materials with Clemson President and members of Executive Leadership Team at Michelin Global HQ France 2023
Press announcement with GE Aviation on Clemson Materials work at Paris Air Show highlighting AMIC 2023 <https://news.clemson.edu/ge-aerospace-and-clemson-university-announce-research-into-advanced-materials-for-flight/>

Updated January 1st, 2026