

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CLEARCORRECT OPERATING, LLC.,
Petitioner,

v.

ALIGN TECH., INC.,
Patent Owner,

Case Nos. IPR2025-00818
IPR2025-00819
IPR2025-00820
IPR2025-00821
Patent Nos. 10,973,613,
11,154,384,
11,648,090,
11,648,091

REPLY DECLARATION OF DR. TIM A. OSSWALD

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I. Introduction

1. I, Dr. Tim A. Osswald, have been retained by Finnegan, Henderson, Farabow, Garrett & Dunner, LLP on behalf of Petitioner ClearCorrect Operating, LLC (“ClearCorrect”) as an expert in the fields of plastics and polymers technology.

2. In this proceeding, I previously provided a declaration dated April 13, 2025. EX1007 (Opening Declaration).¹ My background and qualifications are set forth in my previous declaration. I now provide my opinions in response to certain assertions made by Dr. Kimmel and Yan Chen in their declarations (EX2014 and EX2016) regarding:

- *Tadros*’s copolyester disclosures;
- *Wen*’s disclosures of using multiple thinner layers;
- *Porter*’s disclosures of Tritan as a BPA-free alternative to polycarbonate; and
- adhesive lamination and whether a “tie layer” results in another polymer layer in a multilayer sheet.

¹ I provided a declaration in each of IPR2025-00818, -819, -820, and -821. Each declaration is “EX1007” in the respective proceedings and the content of the declarations are substantially similar. Nevertheless, for clarity, I denote citations to each particular declaration in my Reply herein with “EX1007 (Opening Declaration), ¶__” followed by “(’613 IPR),” “(’384 IPR),” “(’090 IPR),” or “(’091 IPR).”

3. I am being compensated for the time I spend on this matter, but my compensation is not contingent upon my opinions or the outcome of this or any proceeding.

II. Materials Considered

4. Along with the materials I previously considered, I have now considered the materials cited in this declaration, listed in Appendix A. To the extent I am provided with additional documents or information, I reserve the right to offer further opinions.

III. Dr. Kimmel's Opinions Regarding *Tadros* and Copolyesters Are Incorrect

A. Dr. Kimmel Does Not Address *Tadros*'s Disclosure of Polymeric Mixtures Using the Copolyester PETG

5. As I explained in my opening declaration, *Tadros* discloses hard polymeric mixtures of polycarbonate mixed with a copolyester such as PCCD or PETG:

The hard “polymeric mixture” layer of *Tadros* is a “physical mixture[] of two or more thermoplastic polymers,” and “[p]referred polymeric mixtures derived from mixing polycarbonate and polyesters” include polycarbonate mixed with a copolyester such as “**PCCD**,” “**PETG**,” and “PET.”

EX1007 (Opening Declaration), ¶169 ('613 IPR) (quoting EX1003 (*Tadros*), [0022]-[0023] (emphasis added)); ¶173 ('384 IPR); *see also* EX1007, ¶111 ('090, '091 IPR).

6. As I also detailed, *Tadros* discloses certain properties for its polymeric mixtures. EX1007 (Opening Declaration), ¶170 ('613 IPR) (citing EX1003 (*Tadros*), [0068]), ¶174 ('384 IPR); *see also* EX1007, ¶183 ('090 IPR), ¶161 ('091 IPR). *Tadros* discloses that tensile modulus values of its polymeric-mixture hard layers, for example, “should be adjusted” so that the dental appliance can be installed and removed without damaging the patient’s oral cavity. EX1003 (*Tadros*), [0068]. Those values preferably range from “about 1,500 N/mm² to about 2,500 N/mm²,” which I previously explained would be the same as the mixtures’ flexural modulus values and easily exceed the 150,000 psi limitation of the claims. EX1007 (Opening Declaration), ¶170 ('613 IPR) (citing EX1003 (*Tadros*), [0068]); ¶174 ('384 IPR); EX1007 (Opening Declaration), §IV.C.2 ('613, '384, '090, '091 IPR) (explaining POSITA would understand tensile modulus and flexural modulus are the same for isotropic materials, including those of *Tadros*); *see also* EX1007, ¶183 ('090 IPR), ¶161 ('091 IPR).

7. In his declaration, Dr. Kimmel only addresses the PC-PCCD embodiments in *Tadros*, asserting that PCCD is purportedly not a copolyester. EX2014 (Kimmel Declaration), ¶45-53. He never addresses *Tadros*’s disclosures regarding a PC-PETG hard layer. In my opinion, this is a significant omission because PETG is undisputedly a copolyester, as Dr. Kimmel testified. EX1149 (Kimmel Deposition) 62:11-13 (Q. “Is PETG a copolyester?” A. “Yes.”).

8. I agree that PETG is a copolyester. PETG is a polymer produced by reacting three different monomers: a diacid (terephthalic acid) and two diols (ethylene glycol and cyclohexanedimethanol (CHDM)). EX1158 (Zhang), 756. One way of making a copolyester is indeed to react a diacid with two or more diols, as Dr. Kimmel acknowledged during his deposition. EX1149 (Kimmel Deposition), 50:21-51:2 (Q. “So if you have two diols with different structures or two diacids with different structures in your polymerization, that's a copolyester?” A. “Yes.”). Accordingly, because PETG is a copolyester as Dr. Kimmel acknowledges, and *Tadros* discloses using a PC-PETG polymeric-mixture hard layer preferably having a flexural and tensile modulus value above the 150,000 psi minimum of the claims, my opinion is that the claims would have been obvious for this reason—even independent of *Tadros*’s PC-PCCD disclosures.

B. Dr. Kimmel Incorrectly Contends that PCCD Is Not a Copolyester

1. Dr. Kimmel Drives a False Distinction Between Polyesters and Copolyesters

9. Dr. Kimmel incorrectly asserts that PCCD is not a copolyester. EX2014 (Kimmel Declaration), ¶¶45-53. His analysis hinges on the assertion that because *Tadros* states that PCCD is an “cycloaliphatic polyester,” it cannot also be a copolyester. EX2014 (Kimmel Declaration), ¶¶46-49. That is wrong—the polyester class of compounds includes copolyesters.

10. For example, *Tadros* refers to PETG as a “polyester.” EX1003 (*Tadros*), [0023]. PETG, however, is also a copolyester, as Dr. Kimmel acknowledged. EX1149 (Kimmel Deposition), 62:11-13. But regarding PCCD, Dr. Kimmel inconsistently argues that because *Tadros* similarly identifies PCCD as a “polyester” it cannot be a “copolyester.” EX2014 (Kimmel Declaration), ¶50. Dr. Kimmel’s opinion regarding PCCD is incorrect. A POSITA would have understood that, when *Tadros* describes a particular polymer (e.g., PCCD and PETG) as a “polyester,” it does not somehow preclude the polymer from also being a copolyester. I clarified this point in my deposition when I explained that the “cycloaliphatic polyester[s]” referred to in paragraph 22 of *Tadros* are nonetheless copolyesters. EX2017 (Osswald Deposition), 22:4-24:8 (“*Tadros*’s mixtures do contain polycarbonate and copolyesters”).

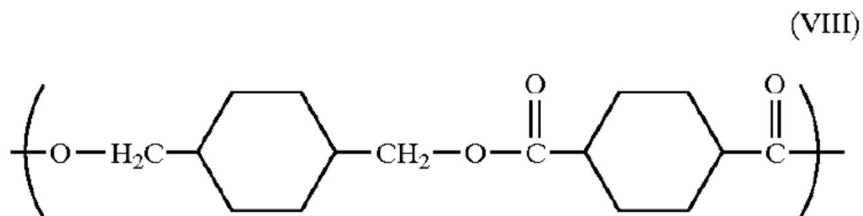
11. As of the ’613 patent’s earliest possible 2012 filing date, a POSITA would have recognized that PCCD—even if described at times as an “cycloaliphatic polyester”—was also a copolyester. My opinion is also supported by Eastman Chemical Company’s U.S. Patent Publication No. 2012/0322951, filed June 17, 2011. EX1153 (Eastman). Eastman Chemical Company is a long-established commercial supplier of polymers and other materials in the field, including Tritan. *Eastman* describes, for instance, using “aliphatic *copolyester* (PCCD).” EX1153 (Eastman), [0001]. *Eastman* further discloses that PCCD copolyester was

commercially available in the prior art. EX1153 (Eastman), [0462] (disclosing use of “commercially available copolyesters,” including “PCCD”).

12. Accordingly, contrary to Dr. Kimmel’s opinions, a POSITA would have understood that describing PCCD as a “cycloaliphatic *polyester*,” as *Tadros* states, does not somehow preclude PCCD from being a “cycloaliphatic *copolyester*” (which it is). EX1003 (*Tadros*), [0022]; EX1153 (Eastman), [0001], [0462].

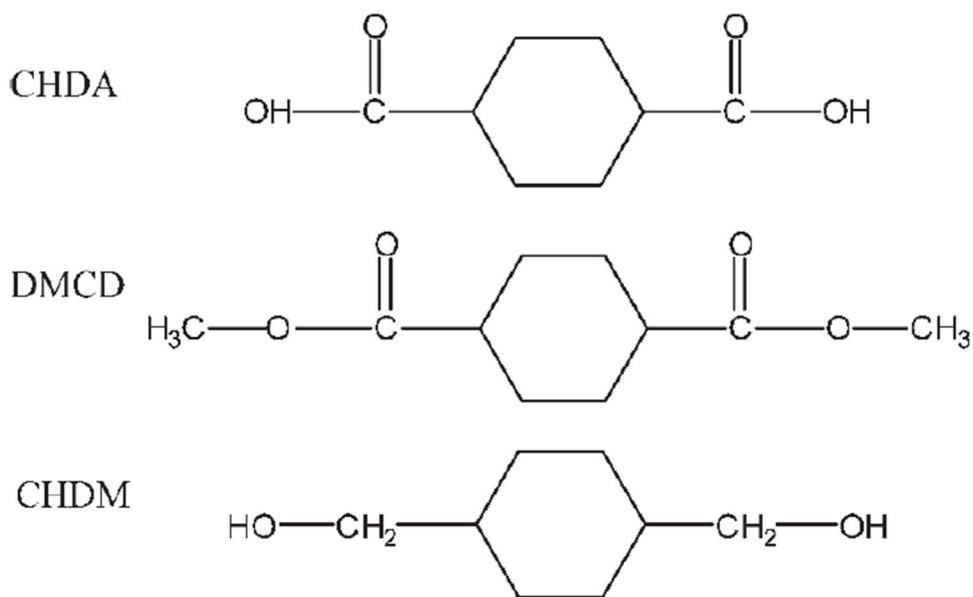
2. Dr. Kimmel Fails to Accurately Identify the Different Monomers in PCCD

13. Dr. Kimmel’s incorrect opinion that PCCD is not a copolyester also originates in large part from his inaccurate reference to *Tadros*’s Formula VIII (reproduced below) as purportedly depicting a single *monomer*.



EX2014 (Kimmel Declaration), ¶50; EX1003 (*Tadros*), [0050]-[0051] (Formula VIII). As I explained during my deposition, Formula VIII depicts a polymer, not a monomer. EX2017 (Osswald Deposition), 25:1-7.

14. PCCD is generally formed from the polycondensation of 1,4-cyclohexanedimethanol (CHDM) with dimethyl 1,4-cyclohexanedicarboxylate (DMCD) or 1,4-cyclohexanedicarboxylic acid (CHDA). EX1160 (Berti), 620.



EX1160 (Berti), 620.

15. Contrary to Dr. Kimmel’s assertions, there are thus at least three monomer units used in the preparation of PCCD—CHDM, DMCD, and CHDA—at least two of which will always be incorporated into the polymer chain. EX1160 (Berti), 620. *Tadros* recognizes these distinct monomers, disclosing that suitable diols for its polymers include “1,4-cyclohexanedimethanol” (CHDM) and suitable diacids include “1,4-cyclohexanedicarboxylic acid” (CHDA) or “dimethyl-1,4-cyclohexanedicarboxylate” (DMCD). EX1003 (*Tadros*), [0042]-[0043], [0046]-[0047]. Dr. Kimmel’s opinion that PCCD has just one monomer is therefore wrong.

16. Dr. Kimmel appears to conflate “monomers” with “repeat units.” EX2014 (Kimmel Declaration), ¶50 (“This recurring unit is a single monomer...”). In addition to differences between monomer units themselves, there are different ways the units can be ordered in a polymer. EX1039 (Osswald 2012), 73-74;

EX1161, 7-8. Monomer units can be combined randomly in a polymer. They can also alternate (e.g., with monomer A and monomer B in a repeating ABABAB pattern). They can also appear in block or graft configurations. *Id.* A schematic of these various configurations for a polymer formed from monomer A and monomer B (excerpted from my textbook MATERIALS SCIENCE OF POLYMERS FOR ENGINEERS) is shown below.

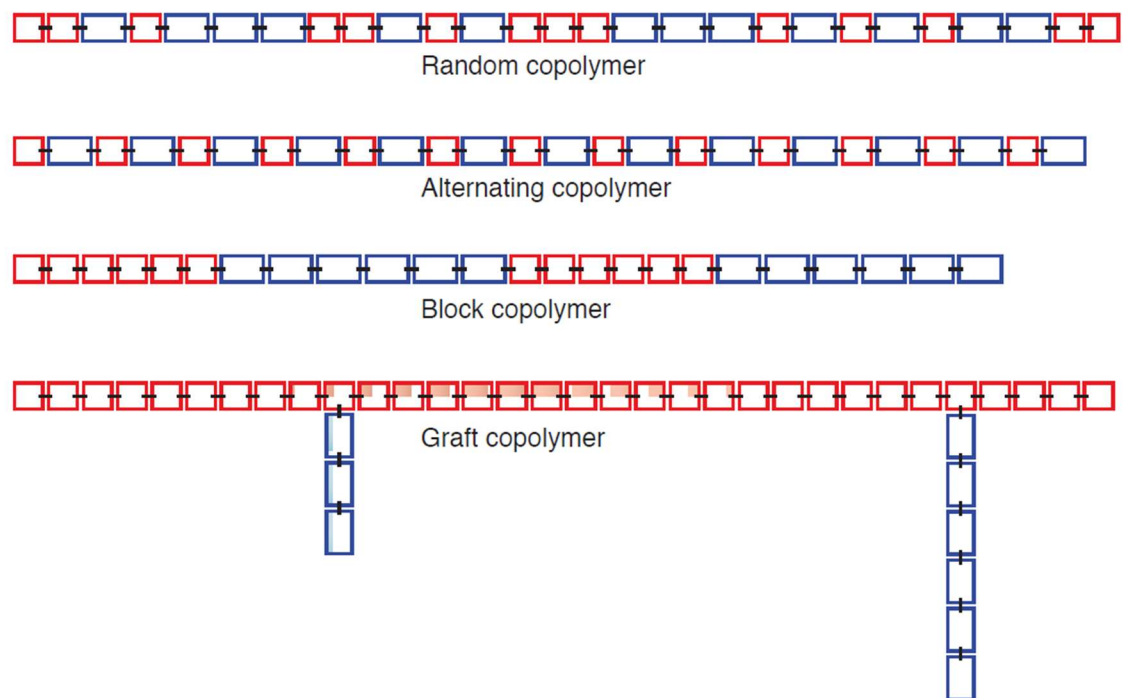


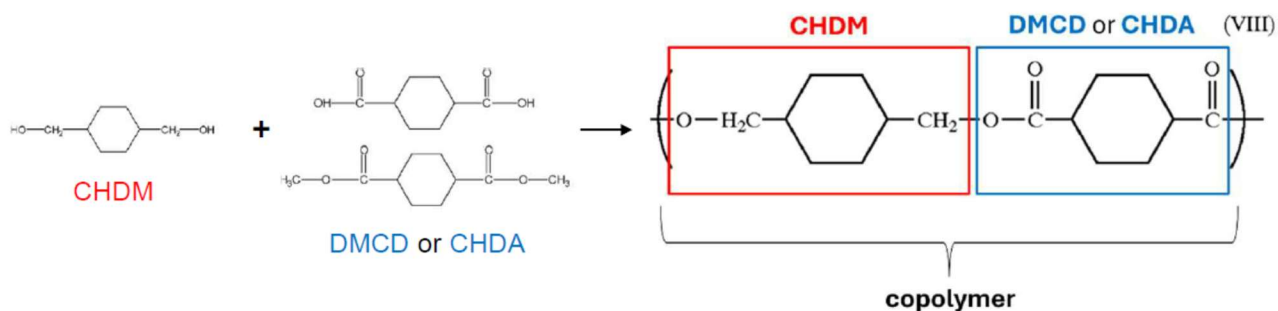
Figure 3.24 Schematic representation of different copolymers

EX1039 (Osswald 2012), 74; *see also* EX1161, 7-8.

17. A repeat unit (also sometimes referred to as a “recurring unit”) depicts an identical section of a polymer chain that repeats throughout the polymer. Repeat units can be represented using the shorthand format “()_n.” EX1039 (Osswald 2012),

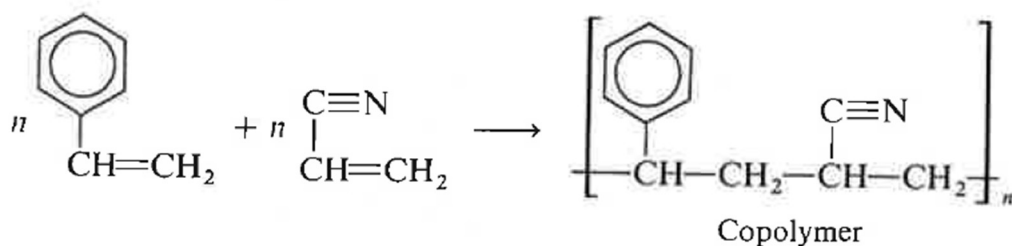
49-50. A POSITA would have understood that each repeat unit can nonetheless consist of multiple monomer units—in other words, the repeat unit itself is a copolymer. As an example, in the figure above, the alternating copolymer has repeat units of (AB)_n. Similarly, the block copolymer has repeat units of (AAAAAABBBBBB)_n. A single repeat unit can thus have the structure of multiple polymerized monomers, contrary to Dr. Kimmel’s opinions.

18. Here, Formula VIII does not depict a monomer—it depicts a polymer. Specifically, it is a copolymer with repeat units of the form (AB)_n.



EX1160 (Berti), 620; EX1003 (*Tadros*), [0050] (Formula VIII (annotated)); EX2017 (Osswald Deposition), 25:1-7 (explaining Formula (VIII) does not depict a monomer, but rather “repeat units of the polymer”). This copolymer structure is also reflected in the full chemical name of PCCD—poly(1,4-cyclohexylenedimethylene-1,4-cyclohexanedicarboxylate).

19. My opinion is also supported by Allcock, CONTEMPORARY POLYMER CHEMISTRY, which further confirms that reacting two different monomers in this manner forms a repeating copolymer unit—not a monomer, as Dr. Kimmel contends.



EX1161 (Allcock), 7 (depicting polymerization of styrene and acrylonitrile monomers to form a copolymer repeat unit).

20. As I also noted above, PETG is a copolymer formed from the monomer units of terephthalic acid, ethylene glycol, and cyclohexanedimethanol (CHDM) and could thus be depicted as a single copolymer repeat unit of the form (ABC)_n. This ability to depict a copolyester as having a single repeat unit therefore does not make it a homopolymer made from a single monomer, as Dr. Kimmel suggests. EX2014 (Kimmel Declaration), ¶50. Rather, PETG is undisputedly a *copolyester*. EX1149 (Kimmel Deposition), 62:11-13 (Q. “Is PETG a copolyester?” A. “Yes.”).

21. Dr. Kimmel’s erroneous identification of the PCCD repeat unit in Formula VIII as a monomer is therefore wrong. Under Dr. Kimmel’s monomer theory, an alternating copolymer (or even many block copolymers) could never exist, since the polymer would still have a single repeat unit (or, as Dr. Kimmel refers to it, a single monomer). For instance, under Dr. Kimmel’s monomer theory, a polymer with the alternating structure (ABCDEF...) _n or the block structure (AAAABBBBBBCCCC) _n could not be a copolymer simply because there is a single

repeat unit. This absurd result would eliminate entire classes of polymers recognized in the field.

22. In his deposition, Dr. Kimmel acknowledged he was familiar with alternating and block copolymers, but he admitted he did not account for these arrangements of copolymers (and therefore copolyesters) in his declaration. EX1149 (Kimmel Deposition), 42:14-48:2. But as Dr. Kimmel acknowledged, a copolymer is formed of two or more different kinds of monomers “full stop,” without any required arrangement of those monomers in the polymer structure. EX1149 (Kimmel Deposition), 48:11-49:3. A POSITA would thus understand that PCCD—which is composed of CHDM and DMCD/CHDA monomers—is undoubtedly a copolymer, which under even Dr. Kimmel’s own opinions makes it a copolyester. *See* EX2014 (Kimmel Declaration), ¶50 (a “copolyester is a copolymer form of a polyester”).

**a. Dr. Kimmel’s Argument That Isomeric Mixtures
Would Not Form a Copolyester is Unsupported and
Contradicted by *Tadros***

23. Dr. Kimmel also asserts that using isomeric mixtures of monomers to produce PCCD, as *Tadros* discloses, would not form a “copolyester.” EX2014 (Kimmel Declaration), ¶52. I disagree.

24. Isomers are distinct molecules that have the same number and types of atoms, but with some of the atoms in a different geometric arrangement. EX1039 (Osswald 2012), 56-57. This arrangement of atoms can influence the properties of

the molecules and the polymers they form. EX1039 (Osswald 2012), 56-57. As an example, the cis- and trans- configurations of 1,4-polybutadiene are shown below.

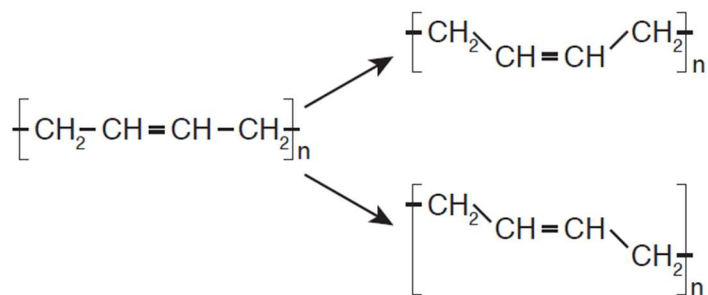


Figure 3.13 Symbolic representation of cis-1,4- and trans-1,4-polybutadiene molecules

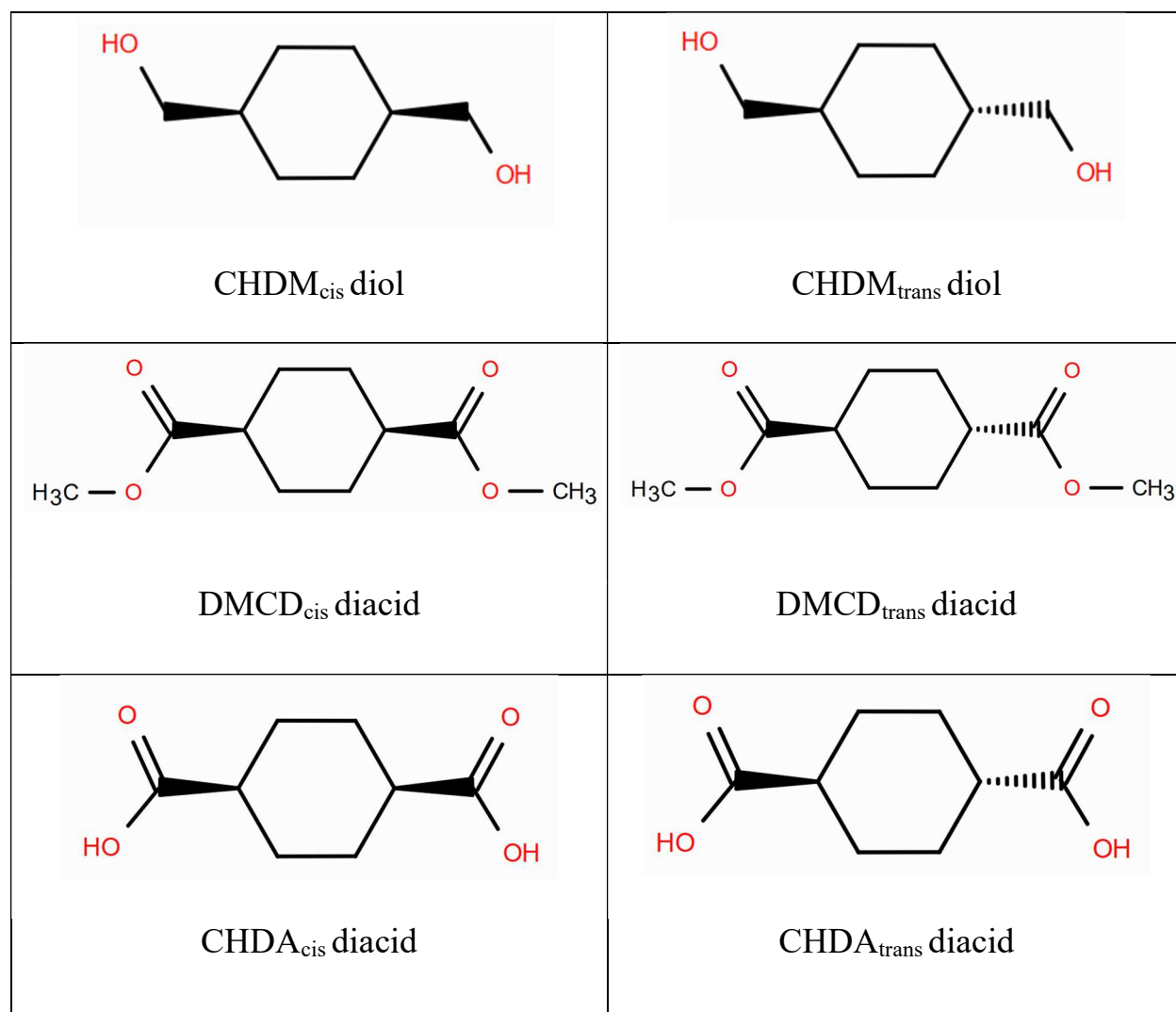
EX1039 (Osswald 2012), 58.

25. Polymers formed entirely of a single type of isomer may have different properties resulting from the difference in geometric arrangement. EX1149 (Kimmel Deposition), 65:19-66:20. For instance, cis-1,4-polybutadiene results in a very elastic rubbery material that can be used to manufacture tires, whereas the structure in the trans-1,4-polybutadiene results in a leathery and tough material that can be used as the outer skin in golf balls. EX1039 (Osswald 2012), 58. As a result of these differences in structure and function, different isomers are thus understood to be different monomer units. EX1039 (Osswald 2012), 56-57; EX1149 (Kimmel Deposition), 67:2-13 (acknowledging “cis monomer” and “trans monomer” properties can vary).

26. As Dr. Kimmel acknowledges, *Tadros* discloses using mixtures of cis- and trans- isomers to produce PCCD. *See* EX2014 (Kimmel Declaration), ¶52; EX1003 (*Tadros*), [0045], [0050]-[0051]. Indeed, *Tadros* discloses that for PCCD, isomeric mixtures of the CHDM, CHDA, and DMCD monomer units should be used. *Tadros* discloses using isomers for the acid components, CHDA and DMCD, explaining that “during hydrogenation, two or more isomers are obtained in which the carboxylic acid groups [e.g., CHDA and DMCD] are in cis- or trans- positions.” EX1003 (*Tadros*), [0045]; *see also* EX1003 (*Tadros*), [0047] (describing mixture of DMCD isomers), [0051] (describing CHDA isomers). *Tadros* discloses that where CHDM is used as the diol component “it is generally preferred to use a mixture of cis- to trans-isomers in ratios of about 1:4 to about 4:1” and more specifically, “it is generally desired to use a ratio of cis- to trans- isomers of about 1:3.” EX1003 (*Tadros*), [0042]. Thus, *Tadros* discloses using distinct cis- and trans- isomers for the diol and diacid units of PCCD, and preferably mixtures of these isomers.²

² Dr. Kimmel wrongly suggests that *Tadros* recommends an “all-trans” PCCD. EX2014 (Kimmel Declaration), ¶51. As described above, *Tadros* discloses a desired “ratio of cis- to trans- isomers of about 1:3.” EX1003, [0042]. *Tadros*’s disclosed preference for trans isomers is simply reflected in the greater percentage of trans isomers in its disclosed isomer ratios. EX1003, [0045].

27. Accordingly, a POSITA would have understood from *Tadros's* disclosures that there are six distinct isomer units for producing PCCD: CHDM_{cis}, CHDM_{trans}, DMCD_{cis}, DMCD_{trans}, CHDA_{cis}, and CHDA_{trans}. EX1003 (*Tadros*), [0042], [0045], [0050]-[0051]; EX1160 (Berti), 620, 629. Their chemical structures are depicted below:



28. Thus, even though PCCD may be depicted at a high level to have an A-B structure, in actuality PCCD contains A_{cis}-, A_{trans}-, B_{cis}-, and B_{trans}- units. One exemplary random copolymer of this form is shown below.



EX1039 (Osswald 2012), 74 (annotated); *see also* EX1160 (Berti), 629 (showing two exemplary configurations of the cis and trans sequences).

29. Accordingly, the isomeric monomers in PCCD are distinct monomer units and, when polymerized, form a copolyester. Indeed, *Tadros* expressly states that “[w]hen a mixture of isomers or more than one diacid is used, a copolyester or a mixture of two polyesters may be used as the cycloaliphatic polyester resin.” EX1003 (*Tadros*), [0045]. In other words, “[w]hen a mixture of isomers... is used” during polymerization, the result is “a copolyester.” EX1003 (*Tadros*), [0045]. *Tadros* thus discloses that, at a minimum, PCCD produced from a mixture of isomers is a copolyester.

30. Dr. Kimmel inaccurately asserts that “even if a mix of cis- and trans-isomers were ... the monomer units ... a POSITA would view such a polymer as a homopolymer.” EX2014 (Kimmel Declaration), ¶52. This assertion (which contradicts *Tadros*) is apparently based on *Brunelle* (EX2019) and *Throne* (EX2020). But neither reference seeks to classify any compound as a “copolyester” or not, let alone states that PCCD is not a copolyester.

31. To the contrary, *Brunelle* acknowledges that using different *cis* and *trans* monomers to produce PCCD can result in different properties, confirming that two or more different diol monomers (*cis/trans*) and/or two or more different diacid monomers (*cis/trans*) are used. EX2019 (*Brunelle*), 4100 (“The properties of PCCD polyesters depend on the *trans/cis* ratio; only the polymers rich in *trans* isomer afford high melting points or fast crystallization.”), abstr. Accordingly, *Brunelle* further supports my opinions that (i) different isomeric molecules are different monomers, (ii) using different monomers can result in varying properties, and (iii) a PCCD polymer formed from a mixture of *cis/trans* monomers is a copolyester—just as *Tadros* discloses. EX1003 (*Tadros*), [0045], [0042], [0050]-[0051]. Moreover, the polymerization *Brunelle* describes as producing PCCD from different isomeric diol monomers and diacid monomers also results in a copolyester even when applying Dr. Kimmel’s more restrictive definition. EX2014 (Kimmel Declaration), ¶49; EX1149 (Kimmel Deposition), 50:20-51:2 (Q. “So if you have two diols with different structures or two diacids with different structures in your polymerization, that’s a copolyester?” A. “Yes.”).

32. Dr. Kimmel cites *Brunelle*’s mention of a PCCD “homopolymer,” which is terminology that *Brunelle* appears to use interchangeably with “pure PCCD.” EX2019 (*Brunelle*), 4101. *Brunelle*’s usage of “pure PCCD” is more accurate, particularly given *Brunelle*’s express acknowledgement that multiple

different monomers are used to produce PCCD, making it a copolymer and also a copolyester (even under Dr. Kimmel's requirements for a copolyester). EX2019 (Brunelle), abstr., 4095, 4100. Moreover, in context, a POSITA would have recognized that *Brunelle's* "homopolymer" language was convenient for distinguishing PCCD from other PCCD/Cy-6-Cy copolymers (as opposed to referring to all PCCD and PCCD/Cy-6-Cy polymers as copolymers), even if not technically accurate. EX2019 (Brunelle), 4101-4102.

33. Dr. Kimmel's reliance on *Throne* is also misplaced, as that reference does not mention PCCD at all. *Throne* is also very inconsistent in its terminology. It first states that if *only one moiety* is used to create a polymer, it is a "homopolymer." EX2020 (Throne), 173. It then states that "reacting *two moieties*, bisphenol A and phosgene," still produces a homopolymer (polycarbonate). EX2020 (Throne), 173; *see* EX1149 (Kimmel Deposition), 48:18-49:3 (Dr. Kimmel testifying, in contrast, that "a copolymer is formed of two or more different kinds of monomers ... [f]ull stop"). But when two other moieties are used, i.e., "styrene monomer is reacted with butadiene monomer," that reaction then results in a "copolymer." EX2020 (Throne), 173. In my opinion, *Throne* thus reflects a subjective, inconsistent, and incorrect approach to polymer terminology.

34. Moreover, *Throne's* use of the term "moiety" in this context is itself technically imprecise: a moiety refers to a recognizable chemical subunit or

fragment *within* an existing molecule, whereas the correct term for the molecular building block used to *create* a polymer through polymerization is “monomer.” A moiety is a molecule fragment you can point to within a finished polymer chain, making it a structural descriptor, not a process descriptor such as a monomer. A POSITA would have recognized this terminological inaccuracy, further undermining the reliability of *Throne* as a reference for defining copolymer nomenclature.

b. Dr. Kimmel Ignores Disclosures of Additional Diols Incorporated into PCCD

35. I also disagree with Dr. Kimmel’s opinion that PCCD is allegedly not a copolyester because a POSITA also would have understood from *Tadros* that high molecular weight PCCD can also be prepared through the incorporation of additional diol components. Both *Tadros* and Dr. Kimmel’s cited *Brunelle* reference recognize that PCCD may include additional diol components.

36. In particular, *Tadros* discloses that additional diols such as ethylene glycol, butanediol, and diethylene glycol can be incorporated into polymer structures, including PCCD. EX1003 (*Tadros*), [0042]. The additional diol components incorporated into the PCCD mixtures in *Tadros* would thus be additional monomers.

37. Likewise, *Brunelle* describes “incorporating volatile diols such as butanediol, ethylene glycol, and diethylene glycol” into the polymer structure of

PCCD. EX2019 (Brunelle), 4095, 4102 (“The second diol will esterify along with the CHDM, forming alcohol-terminated oligomers or build into the polymer”), Table 7; *see also* EX1003 (*Tadros*), [0042]. These are the same volatile diols a POSITA would have known may be incorporated into PCCD based on the teachings of *Tadros*. *See* EX1003 (*Tadros*), [0042]. According to *Brunelle*, PCCDs incorporating additional diol components are useful to balance the ratio of DMCD and CHDM. EX2019 (Brunelle), 4103.

38. A POSITA would thus have understood that PCCD may include these volatile diols as additional monomer units and would have known how to incorporate these monomer units. Moreover, as *Tadros* states, a POSITA would have been readily capable of adjusting the tensile (and therefore also flexural) modulus of the materials used in the hard layer (e.g., PC-PCCD) to achieve the desired properties for use in a dental aligner. EX1003 (*Tadros*), [0068].

39. Given the several distinct monomer units that make up PCCD, a POSITA would have understood it to be a copolymer and, in particular, a copolyester, as *Tadros* discloses. EX1003 (*Tadros*), [0042], [0045], [0050]-[0051]; EX1151 (Eastman), [0001], [0462] (“aliphatic *copolyester* (PCCD)”).

40. I understand that *Tadros* was published as part of research at General Electric (GE), whose plastics division was later acquired by SABIC, a well-known chemical manufacturing company. EX1163 (U.S. Patent No. 7,210,926) (listing

same inventors as EX1003 (*Tadros*) and listing assignee as GE). As noted above, Eastman Chemical Company, like *Tadros*, identifies PCCD as a copolyester. EX1151, [0462]. In my view, this explicit recognition by long-established polymer suppliers in the materials field of PCCD being a “copolyester” is consistent with a POSITA’s understanding of the PC-PCCD mixtures in *Tadros* comprising a copolyester for the reasons described above.

IV. Dr. Kimmel Ignores *Wen*’s Disclosures of the Benefits of Using Sublayers When Thermoforming a Multilayer Sheet

41. Dr. Kimmel does not dispute that *Wen* discloses benefits of using thinner sublayers. EX2014 (Kimmel Declaration), ¶76 (acknowledging *Wen* discloses “(1) a teaching that ‘thinner sublayers conform better to tooth models, allowing for more effective tooth repositioning’; and (2) a teaching that ‘using thinner sublayers improves bonding between layers, particularly between layers having disparate properties’”); EX1007 (Opening Declaration), ¶¶51-56, 124 (’613, ’384, ’090, ’091 IPR). However, Dr. Kimmel alleges that *Wen*’s disclosures about the benefits of using sublayers are limited to a sequential thermoforming process in which the individual layers are thermoformed one by one instead of first being laminated in a multilayer sheet. EX2014 (Kimmel Declaration), ¶¶80-90 (relying on paragraphs [0205]-[0206] of *Wen*). I disagree.

42. Dr. Kimmel does not explain why he fails to address the paragraphs directly in between the paragraphs from *Wen* that he discusses. Dr. Kimmel

addresses *Wen*'s disclosures on sequential thermoforming of individual layers (EX1008, [00205]-[00206]) and its disclosures regarding the advantages of using thinner sublayers (EX1008, [00212]-[00213]). But Dr. Kimmel fails to address the intervening disclosures (e.g., paragraph [00210]) that "two or more polymer sheets may be laminated to one another to form a single sheet that is heated and vacuum-formed over the arch models to provide multi-layer dental aligners." As I noted in my opening declaration, *Wen* identifies the advantages of using thinner sublayers without limiting them to sequentially thermoformed layers. In fact, *Wen*'s discussion of advantages directly follows its disclosure of thermoforming a laminated multilayer sheet. See EX1007 (Opening Declaration), ¶123 ('613, '384, '090, '091 IPR) (discussing EX1008, [00207]-[00208], [00210]). As I explained in my opening declaration, *Wen* then discloses heating and vacuum-forming the pre-formed multilayer sheet over positive arch models. *Id.* *Wen* also explicitly states that the layers of the pre-formed multilayer sheet are laminated by adhesive bonding (i.e., adhesive lamination). EX1008 (*Wen*), [00208]. These disclosures demonstrate that *Wen* is not limited to sequential molding of separate sheets—it also discloses pre-laminated multilayer sheets bonded by adhesive lamination.

43. Dr. Kimmel misrepresents my deposition testimony, asserting that I "admitted" *Wen*'s disclosed benefits of sublayers was limited to one particular thermoforming method (e.g., sequential thermoforming). EX2014 (Kimmel

Declaration), ¶81. Not so. I expressly rebutted that contention, testifying that paragraphs [00212]-[00213] were not so limited and included laminating a multilayer sheet *before* thermoforming. EX2017 (Osswald Deposition), 29:8-37:7. I further testified that *Wen*'s disclosures about the benefits of using multiple, thinner layers were most consistent with thermoforming an already-adhered multilayer sheet. *Id.*

44. Additionally, as I explained in my opening declaration, *Wen* recommends the use of sublayers, disclosing that rather than forming a dental aligner from a single thick layer of material, the aligner may be formed from a plurality of thinner layers of the same material, which more easily conform to the tooth model. EX1007 (Opening Declaration), ¶¶51-56, 124 ('613, '384, '090, '091 IPR); EX1008 (*Wen*), claim 49, [00212]-[00213]. Despite the plain disclosure of *Wen*, Dr. Kimmel nonetheless argues a POSITA would not be motivated to use sublayers.

45. Specifically, Dr. Kimmel analogizes subdividing a layer into thinner layers to “breaking [a piece of plastic] in half then gluing it back together,” asserting that a person of ordinary skill would expect harm rather than improvement. EX2014 (Kimmel Declaration), ¶83. I disagree. This analogy does not accurately reflect multilayer polymer engineering. Multilayer constructions are not equivalent to fractured and re-bonded monolithic materials. Interfacial adhesion, residual stress distribution, deformation behavior during thermoforming, and interfacial constraint

effects can improve performance compared to a single homogeneous layer. EX1007 (Opening Declaration), ¶¶30-31, 49-56 ('613, '384, '090, '091 IPR). Indeed, multilayer laminates are widely used in polymer engineering to tailor performance characteristics. EX1007 (Opening Declaration), ¶¶30-31, 49-56 ('613, '384, '090, '091 IPR).

46. The tooth conformance advantage of pre-laminated thinner layers is particularly well grounded in this regard. EX1007 (Opening Declaration), ¶¶30-31, 49-56 ('613, '384, '090, '091 IPR). When a bonded multilayer stack is heated for vacuum forming, the adhesive or bonding material between layers softens, permitting temporary, localized interply slippage during the thermoforming only. This reduces the effective bending stiffness of the laminate below that of a monolithic sheet of equivalent thickness, allowing the stack to conform more intimately to the tooth model geometry—the precise opposite of the harm Dr. Kimmel predicts. This mechanism is well established: U.S. Patent 4,826,420 states that “ply slippage permits the laminate to gradually and smoothly bend in conformity with the curved shape” in such a process. EX1164 (U.S. Patent No. 4,826,420), 4:6-8, 4:38-54 (noting this interply slippage only occurs when the heat is applied, minimizing delamination and ensuring “the plies are tightly bonded together throughout the laminate at the end of the forming operation.”). Moreover, Morris

(EX1165) presents a rate-dependent forming model for measuring this interply relationship during processes such as thermoforming.

47. Dr. Kimmel's oversimplified analogy thus does not accurately characterize the mechanical phenomena involved. This is especially true where *Wen* tells a POSITA that such a process will work, and where the disclosure of the advantages of thinner sublayers immediately follows disclosure of laminating layers to create a multilayer sheet that can be thermoformed. EX2014 (Kimmel Declaration), ¶76; EX1008 (*Wen*), [00212]-[00213].

V. Dr. Kimmel's Arguments Related to *Porter* and Tritan Are Incorrect

48. As I described in my opening declaration and in my deposition testimony, there were numerous reasons for a POSITA to switch from polycarbonate aligner materials to Tritan. There was a multi-industry shift away from the use of BPA-containing polycarbonates and Tritan was the product that met the need for a BPA-free alternative while also offering performance advantages over polycarbonate. EX1007 (Opening Declaration), ¶¶88-108 ('613, '384, '090, '091 IPR); EX2017 (Osswald Deposition), 53:17-54:2, 57:23-65:10, 71:11-25, 76:18-77:6. For example, Tritan was known to maintain the modulus properties of polycarbonate while providing improved molding capabilities. EX1007 (Opening Declaration), ¶¶100-102 ('613, '384, '090, '091 IPR).

49. Dr. Kimmel asserts that a POSITA would not have viewed *Porter*'s Tritan as relevant or appropriate because it identifies using Tritan in “durable consumer goods, and housewares, not medical applications.” EX2014 (Kimmel Declaration), ¶¶91-92. I disagree.

50. As I explained during my deposition, the entire polymer technology industry “was hungry for a replacement of polycarbonate because of the BPA issues.” EX2017 (Osswald Deposition), 53:4-54:2. Indeed, by the late 1990s, I was teaching students in my engineering design classes about problems with polycarbonate, including its leaching of harmful BPAs. EX2017 (Osswald Deposition), 53:2-15, 61:13-22. But it was not just material scientists who were aware of this issue with polycarbonate—even non-scientists picking up newspapers at the time knew of the BPA issues with polycarbonate based on their day-to-day interaction with the polymer (e.g., in water bottles). EX2017 (Osswald Deposition), 52:17-54:2, 58:3-9, 75:4-14, 83:23-84:4. Moreover, as I detailed in my declaration, a POSITA also would have been aware of other shortcomings of polycarbonate such as its high-thermoforming temperature and susceptibility to environmental stress cracking. EX1007 (Opening Declaration), ¶101 ('613, '384, '090, '091 IPR).

51. *Porter* was published in *Plastics Technology*, which is a journal that material scientists and polymer engineers like myself received. EX2017 (Osswald Deposition), 52:19-54:2. A POSITA reading *Porter*, and other similar plastics-

engineering journals discussing BPA-free Tritan, would have been aware of these shortcomings of polycarbonate in the polymer industry. A POSITA thus would have understood *Porter* to disclose Tritan's applicability for a variety of plastic applications that previously used polycarbonate beyond the illustrative examples expressly discussed in *Porter*, including dental appliances. Indeed, as I testified in my deposition, *Porter* made "a splash in the industry" by providing a solution in the form of Tritan for all of these applications that had used polycarbonate. EX2017 (Osswald Deposition), 52:19-54:2, 70:25-72:8.

52. *Porter's* disclosure of Tritan's improved thermoformability and test results confirming tolerance of harsh environments provided a strong "benchmark" performance that would have reaffirmed a POSITA's understanding that Tritan was durable and suitable for a variety of plastics applications. EX2017 (Osswald Deposition), 62:19-63:9, 65:16-66:7. As I explained in my deposition, this testing would have immediately caught the attention of a POSITA (who would have been aware of polycarbonate's shortcomings) because dishwashers impart strong chemical attacks on polymers and, "if something will resist a dishwasher, it can resist any environmental stress cracking condition." EX2017 (Osswald Deposition), 54:21-58:2; *see also* EX2017 (Osswald Deposition), 62:1-14 (explaining if a material resists the dishwasher environment of temperature, chemicals, soaps, "it's going to be relatively safe in all kinds of environments" and that there were

numerous applications for polycarbonate where stress-cracking was a concern). As I testified, a POSITA would have understood *Porter* as communicating that Tritan performs so well in difficult environments (e.g., where there is high heat and hydrolytic and chemical attack) that it can even withstand the environment of a dishwasher without stress cracking.

53. This environmental stress cracking would have been of particular concern in the dental field, where polycarbonate aligners are exposed to physical stress (e.g., biting/grinding), chemical attacks from foods, and high temperatures inside the mouth. EX2017 (Osswald Deposition), 56:17-57:16, 60:1-10, 63:21-69:25. A POSITA would have understood based on *Porter's* disclosure of Tritan's ability to withstand "benchmark" conditions of a dishwasher that it could also safely withstand conditions in a mouth. *Id.*; *see also* EX2017 (Osswald Deposition), 74:4-75:14 (explaining the orthodontics world welcomed Tritan for being BPA-free while withstanding harsh environments without environmental stress cracking). A POSITA thus would not have read *Porter's* disclosure of the durable, BPA-free Tritan material as limited to consumer goods, as Dr. Kimmel suggests.

54. Dr. Kimmel argues a POSITA would not know if Tritan was suitable for dental repositioning forces, and would therefore not be motivated to incorporate Tritan into a dental appliance. EX2014 (Kimmel Declaration), ¶¶100-105. I disagree.

55. As I explained in my opening declaration, a POSITA would have understood that Tritan was developed to have comparable modulus properties to polycarbonate. EX1007 (Opening Declaration), ¶¶98-108, 118, 125-127, 144-145, 157-166 ('613 IPR), ¶¶ 98-108, 118, 125-127, 145-146, 158-167 ('384 IPR), ¶¶ 98-108, 118, 125-127, 147-164 ('090 IPR); ¶¶ 98-108, 118, 125-127, 148-165 ('091 IPR). It was known in the art that polycarbonate-containing materials were suitable to provide dental repositioning forces. *Id.* Indeed, Ms. Chen testified that Align has marketed a polycarbonate aligner (PC30). EX2016, ¶7. Based on the prior art's guidance, a POSITA would therefore have been motivated to incorporate Tritan—a drop-in replacement for polycarbonate—into dental appliances and would have expected Tritan to deliver effective repositioning forces. EX1007 (Opening Declaration), ¶¶98-108, 157-166 ('613 IPR); ¶¶98-108, 158-167 ('384 IPR); ¶¶98-108, 147-164 ('090 IPR); ¶¶98-108, 148-165 ('091 IPR).

56. Dr. Kimmel also asserts that replacing *Tadros's* polymeric mixture of polycarbonate with a copolyester (e.g., PETG or PCCD) with a Tritan layer would be inconsistent with *Tadros's* disclosures. EX2014 (Kimmel Declaration), ¶¶58-59, 64-72. I disagree.

57. As I explained in my declaration, both *Tadros* and *Porter* disclose materials aimed at maintaining the modulus properties of polycarbonate while improving on issues such as polycarbonate's high thermoforming temperature and

environmental stress cracking risks compared to other polymers (e.g., copolyesters). See EX1006 (*Porter*), 62-63 (Tritan products “can be thermoformed faster and at lower temperatures than polycarbonate” and “[p]roducts molded in polycarbonate are at a greater risk of [environmental stress cracking], particularly in more intricate shapes.”); EX1003 (*Tadros*), [0097], [0100], [0113] (“It is generally desirable for the glass transition temperature of the [hard layer] to be less than that of polycarbonate” because “a lower glass transition temperature and a lower thermoforming temperature generally facilitate an easier deformation of the sheet over the dental mold material.”); EX1007 (Opening Declaration), ¶¶101-102, 110-111, 114 (’613, ’384, ’090, ’091 IPR), ¶161 (’613 IPR), ¶162 (’384 IPR), ¶152 (’090 IPR), ¶153 (’090 IPR) ; EX2017 (Osswald Deposition), 90:6-91:21. *Tadros*, which was filed in 2003, achieved this goal of creating a polymer with the modulus properties of polycarbonate and the molding characteristics of copolyesters by mixing the two polymers (e.g., PC-PETG, PC-PCCD). EX1007 (Opening Declaration), ¶¶110-114 (’613, ’384, ’090, ’091 IPR) (citing EX1003, [0023], [0088]-[0089], [0100], [0113], [0120]). *Tadros* thus went part of the way towards replacing polycarbonate with copolyester, even before Tritan became commercially available. *Porter*, published a few years later in 2007, discloses the achievement of this same goal with Tritan, which maintained the modulus properties of polycarbonate while providing improved molding capabilities. EX1007 (Opening

Declaration), ¶161 ('613 IPR) (citing EX1006, 62-63), ¶162 ('384 IPR), ¶152 ('090 IPR), ¶153 ('090 IPR). *Porter* further discloses that Tritan is BPA-free. *Id.* A POSITA would thus have understood that the two references are entirely consistent with one another, as *Porter* further developed the progress that *Tadros* had made to achieve the same goal. Dr. Kimmel's argument that a POSITA would not have been motivated to combine *Tadros* with *Porter* simply because *Tadros* solved this known problem using a mixture misses the point—the “primary objective” of *Tadros* was not to simply create a polymeric mixture; it was to improve on polycarbonate's performance, just as *Porter* later did. EX2014 (Kimmel Declaration), ¶¶65-66.

58. As I described in my opening declaration, both the materials from *Tadros* (e.g., PC-PETG, PC-PCCD) and materials from *Porter* (e.g., Tritan) were known, suitable materials for rigid layers in multilayer dental aligners prior to May 14, 2012. EX1007 (Opening Declaration), ¶¶101-102, 110-111, 114 ('613, '384, '090, '091 IPR), ¶161 ('613 IPR), ¶162 ('384 IPR), ¶152 ('090 IPR), ¶153 ('090 IPR); EX2017 (Osswald Deposition), 90:6-91:21. Both materials provided advantages over polycarbonate for use as the rigid layer in a multilayer dental aligner. The fact that a POSITA also would have been motivated to continue *Tadros*'s progress by replacing *Tadros*'s PC-copolyester mixtures with the improved, BPA-free Tritan copolyester from *Porter* does not change my opinion that both were disclosed in the art as suitable before the priority date of the '613 patent.

59. Dr. Kimmel also incorrectly asserts that a POSITA would have turned to other BPA-free polymers disclosed by *Tadros* or *Kalili* rather than using Tritan. EX2014 (Kimmel Declaration), ¶¶33, 59-62, 67. I disagree, but in any event, this does not change my opinion that a POSITA would have at least viewed Tritan (disclosed in *Porter*) as a suitable and advantageous option.

60. As I detailed in my opening declaration and testified in my deposition, Tritan was “really the only solution” that maintained the modulus properties of polycarbonate while being BPA-free. EX1007 (Opening Declaration), ¶¶98-108 (’613, ’384, ’090, ’091 IPR); EX2017 (Osswald Deposition), 68:24-69:9, 98:13-100:21. Dr. Kimmel cites nothing to rebut this, as he simply lists BPA-free materials without discussing their modulus properties. EX2014 (Kimmel Declaration), ¶¶33, 59-62, 67. Indeed, many of the materials Dr. Kimmel lists would not be expected to perform comparably to, let alone improve on, the properties of polycarbonate. EX2014 (Kimmel Declaration), ¶¶33, 59-62, 67. As an example, polystyrene (the base plastic used in styrofoam) is more brittle than polycarbonate. EX1039 (Osswald 2012), 9, 14, 51, 449. As another example, polyvinyl chloride (PVC) is vulnerable to embrittlement (a fact that Align cited during prosecution in distinguishing over prior art) and contains harmful non-BPA carcinogens. EX1010, 1226; EX1039 (Osswald 2012), 385, 477-478, 480, 482; EX1166 (Latini). Thus, Tritan’s ability to *improve on* polycarbonate while also being BPA-free (and free of other toxic

chemicals) and avoid stress cracking even in difficult environments is what made it so groundbreaking and is why so many in the industry were excited when articles like *Porter* were published. EX1007 (Opening Declaration), ¶¶98-108, 125 ('613, '384, '090, '091 IPR); *see supra* ¶¶50-53.

61. Unlike the analysis I provided in my opening declaration, which considered the existing prior art such as *Tadros* and *Kalili* in view of *Porter*, Dr. Kimmel considers each reference in isolation. EX2014 (Kimmel Declaration), ¶¶33, 59-62, 67 (considering disclosed polymers in *Tadros* and *Kalili* alone). Dr. Kimmel does not provide any explanation for why he believes a POSITA in 2012 would have looked to those materials first and ignored Tritan entirely, other than the mere fact that alternatives are listed in *Kalili* and *Tadros* (which predate the launch of Tritan). EX2014 (Kimmel Declaration), ¶¶33, 59-62, 67. But as I explained in my deposition, “[n]one of those individual references [are] there in a vacuum. They are all part of the knowledge of a POSITA at the time of the invention.” EX2017 (Osswald Deposition), 85:11-23, 86:5-7; *see also* EX2017 (Osswald Deposition), 90:6-91:21. The fact that *Tadros* or *Kalili* discuss other materials does not change my opinion that a POSITA would have known Tritan was a suitable replacement for polycarbonate by 2012.

62. Dr. Kimmel also argues that a POSITA would view only medical grade materials as being compatible with use in a dental appliance and would therefore not

have been motivated to use the Tritan disclosed in *Porter*. As an initial matter, as I explained in my opening declaration, there were a variety of available Tritan materials, including medical grade, that a POSITA would have been aware of as being suitable for a dental appliance. EX1007 (Opening Declaration), ¶104 ('613, '384, '090, '091 IPR) (Table of Tritan polymers). But even if my obviousness opinion were limited to the Tritan datasheet in *Porter*, Dr. Kimmel provides no support for his “medical grade” theory.

63. Instead, a POSITA would have understood that non-medical grade Tritan may be safely used in dental appliances. As I explained in my opening declaration and deposition, prior-art sources such as *Rafih* disclosed that Tritan could be safely used in oral appliances as a BPA alternative. EX1007 (Opening Declaration), ¶98-100 ('613, '384, '090, '091 IPR); EX2017 (Osswald Deposition), 96:16-23, 97:12-24. *Rafih* states that any Tritan copolyester, without limitation, would be suitable for such a device. EX1104 (*Rafih*), 5:55-59, claims 2, 9, 10. Further, the specific Tritan used in the appliance of *Rafih* (Tritan EX401) is not listed as being medical grade. EX1118, 3-4. Likewise, the Texin 990R material that *Kalili* recommends for use in a dental aligner is not medical grade. EX1005 (*Kalili*), [0069]; EX1009 (Texin 990R). *Tadros* also imposes no medical-grade restrictions on materials for its disclosed dental aligners. A POSITA would therefore understand that non-medical grade materials are suitable for use in multilayer dental appliances.

As to *Rafih*, Dr. Kimmel argues that the appliance was not a dental aligner, but this does not change the fact the prior art discloses Tritan for use in a dental application.

VI. Dr. Kimmel's Arguments Related to Adhesive Lamination Are Incorrect

A. Dr. Kimmel Fails to Identify any Better Technique than Adhesive Lamination

64. In my opening declaration, I detailed common methods of combining polymer sheets that were (and still are) well-known in the field. EX1007 (Opening Declaration), ¶¶31-38 ('613, '384, '090, '091 IPR) (coextrusion), ¶¶39-42 (adhesive lamination), ¶45 ("either lamination or coextrusion would be successful in creating a dental aligner"), ¶51. Among these common methods, a POSITA would have recognized that adhesive lamination was a suitable and desirable technique for combining TPU layers with polycarbonate-copolyester or Tritan layers, including because it was a "basic" technique that did not use high heat and lead to mixing or cross-linking of the layers, and thus would have been expected to preserve the layers' desirable properties. EX1007 (Opening Declaration), ¶¶40-41 ('613, '384, '090, '091 IPR), ¶¶150, 239 ('613 IPR), ¶¶151, 231 ('384 IPR), ¶¶169, 193 ('090 IPR), ¶¶170, 215 ('091 IPR); EX1005 (*Kalili*), [0069] (describing Texin 990R's "outstanding" properties); EX1006 (*Porter*) (describing Tritan's high-performance properties, including surviving a polymer's toughest challenge—a dishwasher cycle); EX1043 (*Troughton*), 147 ("[A]ny thermoplastics can be joined with

adhesive bonding.”). As I detailed in my opening declaration, in addition to the explicit disclosure of adhesive lamination in the prior-art references themselves (e.g., EX1008, [0208]), the motivation to preserve desirable layer properties disclosed in the prior art would have motivated a POSITA to use adhesive lamination. EX1007 (Opening Declaration), ¶¶104 n.2, 120, 123, 140 n.3 (’613, ’384, ’090, ’091 IPR), ¶¶150, 164, 170 n.5, 211, 239 (’613 IPR), ¶¶151, 165, 174 n.6, 217 n.7, 231 (’384 IPR), ¶¶161, 187, 188 n.5, 193, 195-196, 200, 209, 237, 241 (’090 IPR); ¶¶170, 181 n.5, 184, 189, 204, 207, 215, 219, 226, 230, 246, 249, 263, 268, 270, 272, 274, 280, 288, 291, 295, 301, 315, 330, 333, 337, 343-344 (’091 IPR).

65. In response, Dr. Kimmel does not dispute that a basic technique like adhesively laminating layers before thermoforming was known to and within the capabilities of a POSITA. Dr. Kimmel also does not identify any fabrication method better than adhesive lamination—in fact, he refused to take any such position during his deposition. EX1149 (Kimmel Deposition), 94:20-95:8 (Q. “[H]ow is co-extrusion preferable to adhesive lamination in terms of how the layers are adhered? A. “I haven’t -- first of all, I haven’t made that assumption. And second of all, it’s not a question that I’ve considered....”).

66. Instead, when asked to contrast coextrusion with adhesive lamination, Dr. Kimmel testified that “co-extrusion is an extremely complex process.” EX1149

(Kimmel Deposition), 79:1-80:1 (“you could write a book about [co-extrusion]”). In my opinion, that complexity was all the more reason that POSITA would have been motivated to use a more “basic” technique like adhesive lamination.

67. Dr. Kimmel also was asked during his deposition about my testimony that coextrusion “may lead to molecular diffusion or mixing between the layers, as well as cross-linking, that can change the properties of the polymers within a layer,” which he cited in his declaration. EX1149 (Kimmel Deposition), 80:3-86:15. He was unwilling to disagree with my testimony. EX1149 (Kimmel Deposition), 81:19-82:3 (“I haven’t said that I disagree with him....”).

68. Other than expressing how “complex” coextrusion is, Dr. Kimmel was largely unwilling to answer any other questions about coextrusion during his deposition, despite his testimony that he has first-hand experience performing coextrusion. EX1149 (Kimmel Deposition), 30:16-31:16 (describing his work with “state-of-the-art equipment for co-extruding multilayer films”), 71:21-72:2, 73:4-18. I have included some of this testimony below:

- **Refusing to answer background questions on how coextrusion works:**

- Q. How would someone create a multilayer sheet with co-extrusion?

- A. Yeah, I mean, I -- that’s well beyond what I’ve talked about here....That -- so that -- there was no need for me to undertake a discussion of co-extrusion because [Dr. Osswald] didn't care about co-extrusion.

He wanted to use adhesive lamination, and so I spent some time discussing adhesive lamination.

EX1149 (Kimmel Deposition), 72:3-73:2.

➤ Q. Does co-extrusion use heat?

A. But I haven't addressed co-extrusion in my declaration. I've only quoted what Dr. Osswald said. I haven't discussed what co-extrusion is or isn't.

EX1149 (Kimmel Deposition), 96:4-11.

➤ Q. How do the different layers in a multilayer sheet adhere to each other in a co-extrusion process?

A. Yeah. I mean, again, that's -- that's a complicated question. There's all kinds of different answers and it's well beyond the scope of anything that I talked about in the declaration. It's just -- I -- you know, it's -- yeah. I leave it at that.

Q. To clarify, you are unwilling to answer the question of how the layers in a co-extruded multilayer sheet might adhere to each other?

A. [I]t's beyond the scope of what I've written here, and my understanding is that -- that you're supposed to be asking me questions about what I've written, and that doesn't -- what you're asking about is not what I've written. It's nowhere in here. Because my concern was what Dr. Osswald said and didn't say and that's what this is about.

EX1149 (Kimmel Deposition), 89:12-90:22.

- **Refusing to answer questions about whether layers can delaminate after being joined in a coextrusion process:**

➤ Q. Is there any risk of layer delamination when you are making a multilayer sheet using a co-extrusion process?

A. Yeah, I -- you know, that's beyond what I've discussed here.

EX1149 (Kimmel Deposition), 74:7-13

➤ Q. Is delamination a risk for co-extrusion processes?

A. It's -- it's not -- it's not one of the subjects that Dr. Osswald includes in his very brief statement in which he rejects co-extrusion as a way of combining these layers.

EX1149 (Kimmel Deposition), 75:15-76:2

➤ Q. And my question is whether the same delamination is a possibility in co-extrusion.

A. Yeah, I haven't expressed an opinion about that.

Q. So you don't know?

A. I haven't expressed an opinion about it.

EX1149 (Kimmel Deposition), 77:12-20.

➤ Q. You talk about co-extrusion processes. You compare them to adhesive lamination, which you say has a danger of delamination. So my question is whether co-extrusion has a danger of delamination.

A. If we look at what I say in 116, what happens when you're using an adhesive...there's always the risk of forming bubbles....And, you know, co-extrusion is an extremely complex process. There's variations in the process and the type of equipment, all kinds of variables, and I didn't see any need to get into that discussion here....

EX1149 (Kimmel Deposition), 78:1-79:9.

- **Refusing to answer whether coextrusion offers advantages over adhesive lamination:**

- Q. In your personal experience, how is co-extrusion preferable to adhesive lamination in terms of how the layers are adhered?

A. I haven't -- first of all, I haven't made that assumption. And second of all, it's not a question that I've considered because I didn't think it was relevant to the points I was trying to make about Dr. Osswald's assertions.

EX1149 (Kimmel Deposition), 94:20-95:8.

- Q. But despite the fact that you address those issues, you're not willing to answer questions about co-extrusion processes that you contrast with adhesive lamination; is that right?

A. Yeah, I don't believe that the -- that my discussion of adhesive lamination has anything to do with what would happen in co-extrusion. This is a specific discussion of the process that Dr. Osswald is recommending and relied upon that is independent of anything else. It's -- it's a discussion of co-extrusion. I don't think there's any -- any comparison of co-extrusion to adhesive lamination. This is evaluating adhesive lamination standing on its own as a process.

EX1149 (Kimmel Deposition), 91:2-92:4.

- Q. So you, in that sentence [of Paragraph 112], have compared co-extrusion to adhesive lamination, right?

A. Only in terms of the general nature of the process, not in terms of its details.

Q. You say in this sentence in Paragraph 112 things that you think make adhesive lamination undesirable, but you're not willing to specify what actually happens in a co-extrusion process that makes it different; is that correct?

A. I don't cover that subject because it's not necessary to make the points I'm trying to make, and it's beyond the -- it's beyond the scope of my discussion.

EX1149 (Kimmel Deposition), 92:16-94:5.

69. Dr. Kimmel has thus failed to rebut the motivation to use adhesive lamination I describe in my opening declaration, which as noted above, was based in part on a POSITA's comparison of adhesive lamination to other alternatives such as coextrusion.

B. Dr. Kimmel Raises Speculative Issues that Are Not Unique to Adhesive Lamination and that Do Not Differentiate It from Other Techniques

70. In his declaration, Dr. Kimmel raises hypothetical issues that he states might arise from adhesive lamination, such as risks of slippage, delamination, bubbles, and “similar types of failure.” EX2014 (Kimmel Declaration), ¶¶83, 115, 116. But he never asserts that these theoretical issues are unique to adhesive lamination or even that they differentiate it from any other technique, such as coextrusion. EX1149 (Kimmel Deposition), 92:16-94:5. Indeed, they do not—the same issues (e.g., delamination, bubbles) can occur during coextrusion. EX1007 (Opening Declaration), ¶¶ 31, 40-41, 45 ('613, '384, '090, '091 IPR) (discussing adhesion strength and predictability as factors POSITA would consider when selecting manufacturing technique); EX1019 (Schrenk), 150 (describing “delamination” as a *coextrusion problem* that can be remedied with adhesives). Accordingly, none of the hypothetical concerns Dr. Kimmel raised differentiate

adhesive lamination from coextrusion or provide any reason to not use adhesive lamination, which a POSITA was well-equipped to perform.

71. Dr. Kimmel also asserts that other hypothetical risks could arise with adhesive lamination, citing Ebnesajjad's handbook (EX1042), but he again never asserts that those risks are unique to adhesive lamination or meaningfully differentiate it from other techniques, such as coextrusion. EX2014 (Kimmel Declaration), ¶¶110-115. For example, Dr. Kimmel states that using adhesives risks joint failure due to the "warm, wet environment of the mouth." EX2014 (Kimmel Declaration), ¶¶113-114. But coextruded appliances would be subjected to the same environment (and may also use adhesives, as I detail above). A POSITA would have recognized that the primary engineering task was selecting the right structural polymers that would perform in the warm, wet environment of the mouth, and suitable options were indeed known in the art, such as polycarbonate-copolyester mixtures disclosed in *Tadros*, Texin disclosed in *Kalili*, and Tritan disclosed in *Porter*. See, e.g., EX1003 (*Tadros*), [0022]-[0023]; EX2016 (Chen Declaration), ¶7 (describing prior-art polycarbonate aligners), EX1005 (*Kalili*), [0069] (Texin provides "good hydrolytic stability, microbial resistance, teeth whitening, oral freshness," etc.); EX1006 (*Porter*) (touting Tritan's performance). A POSITA would have reasonably expected to succeed in choosing a suitable adhesive glue or solvent to adhere those layers.

72. As another example, Dr. Kimmel alleges *Ebnesajjad* raises concerns about bacterial susceptibility. EX2014 (Kimmel Declaration), ¶114. However, the full excerpt of the passage Dr. Kimmel cites discloses that these concerns exclusively refer to “[n]atural or vegetable-origin adhesives.” See EX1042, 5 (“Natural or vegetable-origin adhesives are subject to attack by bacteria, mold, rodents, or vermin.”). Elsewhere, *Ebnesajjad* discloses that nontoxic, water-resistant materials can effectively be used as an adhesive, which would be suitable for dental applications. EX1042, 144-45, 177 (identifying adhesives that are “physiologically harmless and hence preferred for laminating adhesives used for food packaging applications,” have “good aging properties and resistance to media,” and offer “very good adhesion to many substrates and high adhesion strengths”). A POSITA would have known to use nontoxic materials as an adhesive for an appliance designed to be used in the mouth.

73. Dr. Kimmel also states that some solvents can present health problems and that some adhesives could interfere with thermoforming. EX2014 (Kimmel Declaration), ¶¶113-114. As with the other speculative concerns detailed above, these assertions are tantamount to contending that one would use *no skill* in performing adhesive lamination. My understanding, in contrast, is that a POSITA is allowed to use ordinary skill and ordinary creativity and thus would logically have selected one of the solvents or adhesives that does not pose a health risk in a dental

aligner, does not unpredictably alter the bulk properties of the layers, and would not interfere with thermoforming. Dr. Kimmel nowhere disputes that suitable solvents and adhesives were known for use in adhesive lamination, or that a POSITA was fully capable of identifying them. The fact that not *all* solvents or adhesives may be suitable for *all* adhesive-lamination applications does not mean that adhesive lamination would somehow not have been an obvious technique for a POSITA to use.

74. Dr. Kimmel's opinions are also inconsistent with the '613 patent specification itself.³ For combining sublayers into the soft layers that would be in direct contact with the mouth in the final *soft-hard-soft* configuration, the '613 patent *only* discloses using lamination, not coextrusion. EX1001, 6:52-64. The '613 patent does not identify any concerns about slippage, delamination, bubbles, bacterial susceptibility, or any of the other hypothetical risks that Dr. Kimmel posits. Nor does the '613 patent disclose any special techniques, adhesives, or solvents that would be necessary to adhere the sublayers or address any such concerns. In my opinion, if Dr. Kimmel's speculative concerns posed an actual problem, a POSITA would have expected the '613 patent to have at least addressed them. But the '613 patent does not do so, and it instead relies exclusively on lamination for the soft layers and a POSITA's background knowledge in carrying out that technique.

³ The '384, '090, and '091 patents share similar specifications.

75. Moreover, as I explained in my opening declaration, the prior art recommended using lamination, including adhesive lamination, and thus established that this well-known technique was suitable for making multilayer polymer sheets used in dental aligners. EX1007 (Opening Declaration), ¶¶41, 123 ('613, '384, '090, '091 IPR), ¶¶150, 155, 164, 167, 211, 239 ('613 IPR), ¶¶151, 156, 165, 231 ('384 IPR), ¶¶155, 169, 174, 178, 193, 196, 200, 237, 241 ('090 IPR), ¶¶156, 170, 175, 189, 204, 207, 208, 219, 223, 226, 230, 246, 249, 263, 268, 270, 272, 274, 276, 280-281, 288, 291, 295, 301, 315, 330, 333, 337, 343-344 ('091 IPR). For instance, *Wen* describes using lamination methods with “adhesives” to connect “hard” layers of copolyesters or polycarbonates with “softer” polyurethane layers. EX1008 (*Wen*), [00198], [00201], [00208]. A POSITA would also have understood that *Kalili* describes lamination, as it discloses fabricating a repositioning appliance from a “laminate sheet” made of “a polycarbonate sheet laminated with lower modulus polyurethane,” encompassing adhesive lamination. *See, e.g.*, EX1005 (*Kalili*), [0056], [0063], [0074], [0082], [0088]-[0089], [0091], [0098]. Likewise, a POSITA would have understood that *Tadros* uses lamination based on its disclosure of “dispos[ing]” additional soft layers on the surface of an already-formed hard layer. EX1003 (*Tadros*), [0073]. The prior-art references’ use of lamination methods, including adhesive lamination, thus provides further confirmation that adhesive lamination was a suitable manufacturing method. And, like the '613 patent, none of

these references mentions any of Dr. Kimmel's speculative concerns or requires following any special instructions on how to carry out adhesive lamination, which a POSITA already knew how to perform.

C. Dr. Kimmel's Speculation that Adhesive Lamination Could Change Layer Properties Is Unsupported

76. As I explained in my opening declaration, a POSITA would have been motivated to use methods such as adhesive lamination that would preserve the properties of the polymers. EX1007 (Opening Declaration), ¶¶104 n.2, 120, 123, 140 n.3 ('613, '384, '090, '091 IPR), ¶¶150, 164, 170 n.5, 211, 239 ('613 IPR), ¶¶151, 165, 174 n.6, 217 n.7, 231 ('384 IPR), ¶¶161, 187, 188 n.5, 193, 195-196, 200, 209, 237, 241 ('090 IPR); ¶¶170, 181 n.5, 184, 189, 204, 207, 215, 219, 226, 230, 246, 249, 263, 268, 270, 272, 274, 280, 288, 291, 295, 301, 315, 330, 333, 337, 343-344 ('091 IPR). Dr. Kimmel argues that "meeting the claim limitations is not a reason for a POSITA to make combination." EX2014 (Kimmel Declaration), ¶ 108. But my opinion has nothing to do with meeting claim limitations. Rather, the motivation to preserve the *desirable* properties of polymers identified in the prior art as suitable for dental aligners is reason enough to select adhesive lamination. Indeed, a POSITA would have been motivated to select a predictable method of manufacturing dental appliances that would not alter layer properties that the prior art discloses would be

effective.⁴ Here, *Kalili* touts Texin 990R as having “outstanding” properties for use in a soft layer. EX1005, [0069]. *Tadros* describes PC-copolyester mixtures with good properties for a hard layer. EX1003 (*Tadros*), [0023], [0068], tbls. 2-4. *Porter*, as I explained in my opening declaration and my deposition, reported the remarkable breakthrough of Tritan as a polycarbonate replacement with the ability to withstand the “worst enemies” of polymers. EX1006; EX2017 (Osswald Deposition), 64:22-65:10. A POSITA would have been motivated to use a fabrication method that preserves those desirable properties—indeed, those properties were reasons for selecting those materials in the first place. Manufacturing methods such as adhesive lamination provide this predictability by keeping each layer intact (rather than mixing or cross-linking the layer materials via heat during extrusion), thus maintaining the properties of the polymer when it is joined to another layer. EX1007 (Opening Declaration), ¶150 (’613 IPR), ¶151 (’384 IPR); ¶169 (’090 IPR), ¶170 (’091 IPR).

⁴ Dr. Kimmel also misstates my declaration in arguing that using adhesive lamination would be unpredictable. EX2014 (Kimmel Declaration), ¶115. That portion of my declaration states that “alter[ing] the relative placement of the hard and soft layers or replac[ing] layers with other polymers without guidance to do so is unpredictable.” EX1007 (Opening Declaration), ¶145 (’613, ’384 IPR), ¶146 (’090 IPR), ¶147 (’091 IPR). Using adhesive lamination does not alter the placement of hard and soft layers within a dental appliance, nor does it replace polymers without guidance to do so. For each of the polymer materials that I cite in my combinations, the prior art provides guidance to select that material.

77. In an attempt to overcomplicate the basic technique of adhesive lamination, Dr. Kimmel cherry-picks excerpts from the most extreme processes addressed in *Ebnesajjad*. EX2014 (Kimmel Declaration), ¶114. Dr. Kimmel's analysis fails to address *Ebnesajjad* as a whole, including disclosures that contradict his statements. Further, his assertions do not change the fact that a POSITA would have known how to implement basic adhesive lamination processes to form a suitable multilayer appliance, as I described in my opening declaration. EX2014 (Kimmel Declaration), ¶¶111, 114.

78. Dr. Kimmel argues that *Ebnesajjad* discusses adhesive lamination as including “diffusion” and “cross-linking.” EX2014 (Kimmel Declaration), ¶¶110-111. But he appears to rely on a method that employs significant heating (e.g., above the melting temperatures of the adhesive and adherend), which *Ebnesajjad* does not identify as necessary to achieve adhesion. *Id.* (citing EX1042 (*Ebnesajjad*), 11 (added page number)). Dr. Kimmel thus appears to selectively pick a method that approximates the high-heat conditions also used in coextrusion. He ignores the vast majority of adhesive lamination techniques that *do not* use heating above the melting temperatures and thus would not cause such diffusion or cross-linking. EX1042, 6-9, 154 (adhesives and solvents used for adhesion by mechanical interlocking of layers, electrostatic effects, wetting, adhesive tape, etc.).

79. *Ebnesajjad* also discusses solvent-based adhesive lamination processes. EX1042, 107, 172-173. In basic solvent-based processes, adhesion occurs based on the surface morphology of the layers, not heating. A solvent temporarily softens the surface of the substrate. EX1042, 412 (describing solvent-based processes). When pressed together, the softened interfaces of the structural layers adhere through physical interlocking and conforming of the surfaces (not chemical cross-linking). *Id.* Once the solvent evaporates, all that remains are the solid structural polymer layers adhered together, without any chemical alteration of the substrate or change to the bulk polymer properties, and without any residual adhesive material remaining between the polymer layers. EX1042, 412 (“Adhesion is attained by means of evaporation of the solvent.... a self-bond between the polymeric components is promoted by the temporary presence of a solvent in the absence of an extraneous adhesive”). A POSITA would thus have understood that, like other adhesive lamination methods, the use of solvents in adhesive lamination would not require significant heating and would maintain the properties of the polymer when it is joined to another layer. EX1007 (Opening Declaration), ¶¶104 n.2, 120, 123, 140 n.3 (’613, ’384, ’090, ’091 IPR), ¶¶150, 164, 170 n.5, 211, 239 (’613 IPR), ¶¶151, 165, 174 n.6, 217 n.7, 231 (’384 IPR), ¶¶161, 187, 188 n.5, 193, 195-196, 200, 209, 237, 241 (’090 IPR); ¶¶170, 181 n.5, 184, 189, 204, 207, 215, 219, 226, 230, 246, 249, 263, 268, 270, 272, 274, 280, 288, 291, 295, 301, 315, 330,

333, 337, 343-344 ('091 IPR). Indeed, *Ebnesajjad* cautions that solvents that modify or weaken components should be avoided. EX1042 (*Ebnesajjad*), 172.

80. Dr. Kimmel also argues that *Ebnesajjad*'s adhesive lamination can involve "harsh surface modification techniques, mechanical blasting and material removal, chemical etching using corrosive chemicals, heat melting, and scorching." EX2014 (Kimmel Declaration), ¶111. However, *Ebnesajjad* makes a clear and consistent distinction throughout his handbook between surface preparation methods that physically clean or roughen a substrate without altering its chemical composition, on the one hand, and those that deliberately modify the substrate's surface chemistry on the other hand. As an example, *Ebnesajjad* discloses surface preparation methods such as degreasing, abrasion, and material removal that are merely intended to clean and roughen the surface—not chemically modify it. EX1042, 16-17. *Ebnesajjad* distinguishes these physical-based optimization techniques from "severe" chemical surface modifications where adhesion would be "close to zero," such as in PTFE fluoropolymers. EX1042, 51; *see also* EX1042, 16 (stating that "degreasing alone, or degreasing followed by abrasion and further degreasing, is sufficient for many adhesive bonds"). As I explained in my opening declaration, a POSITA would have understood that thermoplastics, such as the copolyesters and TPUs in the Grounds here, would be expected to adhere and would thus not require "severe" chemical modifications. EX1007 (Opening Declaration),

¶41 ('613, '384, '090, '091 IPR) (citing EX1043 (Troughton): “[A]ny thermoplastics can joined with adhesive bonding”). A POSITA would have known to avoid using unnecessary, extreme chemical modifications.

81. Accordingly, Dr. Kimmel’s attempts to identify hypothetical disadvantages in “certain” applications of adhesive lamination do not change the fact that a POSITA (1) would have been motivated to use adhesive lamination because it would predictably preserve polymer properties within a layer, unlike coextrusion and (2) would have known how to implement this “basic” process to create a multilayer sheet for making a dental appliance.

D. Dr. Kimmel Incorrectly Equates an Interfacial Adhesive with a Structural “Polymer Layer”

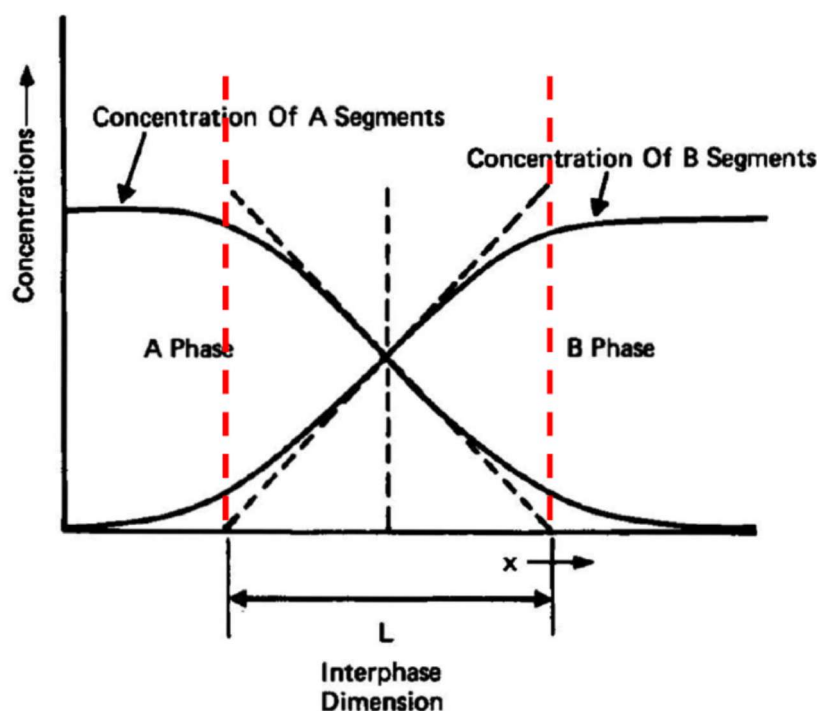
82. Dr. Kimmel argues that an interfacial adhesive polymer applied between the soft and hard layers of the proposed obviousness combinations should be counted as a “polymer layer” in the claims. EX2014 (Kimmel Declaration), ¶¶118-123. His argument is inconsistent with how Align has interpreted the term and how a POSITA would understand the role of an adhesive.

83. To start, as I discussed above, certain adhesive lamination processes such as those using solvents do not leave behind a residual interfacial adhesive at all. EX1042 (Ebnesajjad), 144-45, 172-173. After the solvent evaporates, all that remains are the structural polymer layers adhered together. Dr. Kimmel’s arguments

are thus directed only at certain types of adhesive lamination processes that leave behind an interfacial adhesive.

84. Dr. Kimmel's opinion is also contradicted by Align's other positions and statements, which do not identify thin, interfacial binding layers between the hard and soft layers of a dental appliance as "layers." Align's SmartTrack material is made using a coextrusion process (EX2016 (Chen Declaration), ¶42), which as I explained in my opening declaration, produces interlayer mixing and, at the elevated temperatures involved, may lead to cross-linking of the substrate polymer layers. EX1007 (Opening Declaration), ¶31 ('613, '384, '090, '091 IPR). The elevated processing temperatures in coextrusion produce an interfacial layer between the hard and soft polymer layers consisting of a physical mixture of both polymers through interdiffusion, and can additionally lead to cross-linking of the polymer chains within that interfacial region, as the art recognized. EX1007 (Opening Declaration), ¶31 ('613, '384, '090, '091 IPR); EX1155 (Kim), 258 (information about "the interfacial layer thickness is very important to predict the adhesive bond strength of coextruded products"), 259-268 (reporting thicknesses and compositions of interfacial layers of coextruded products); EX1154 (Yue) (proposing model to measure the interfacial layer created during intermolecular diffusion, as occurs during coextrusion).

85. Indeed, as *Schrenk* discloses, coextrusion involves “molecular interpenetration” from one layer (or “phase”) into another. EX1019, 148 (“polymer segments of one phase diffuse across the interface into the other phase”). As depicted below, there is an intermediate, interfacial layer between polymer layer A and polymer layer B that has a different composition of a *mixture* of A and B:



EX1019, 149, Fig. 17 (showing concentration of polymer materials A and B in the “interphase” (or interfacial) region between layers A and B) (red annotations added). *Schrenk* discloses that the interpenetration of polymer A into layer B (and vice versa) is one of the factors that determines the “interlayer adhesion of the final product.” EX1019, 148-149.

86. But when identifying the layers in the coextruded SmartTrack product, Ms. Chen only identifies three layers—a soft polymer layer, a hard polymer layer, and another soft polymer layer. EX2016 (Chen Declaration), ¶15. She did not count any of the interfacial layers that result from coextrusion, which assists in adhering the layers together, as their own independent “polymer layers.” Dr. Kimmel agreed with Ms. Chen, stating that “[t]he specific arrangement of layers used in ST30 aligners is a three-layer configuration, with a hard layer formed of a hard copolyester material disposed between two soft layers formed of a soft thermoplastic polyurethane elastomer material.” EX2014 (Kimmel Declaration), ¶126. Dr. Kimmel, like Ms. Chen, did not count interfacial layers as their own independent “polymer layers,” notwithstanding the different chemical/polymer composition of those interfacial layers as compared to the bulk structural layers. Had they done so, SmartTrack would have been considered a five-layer appliance rather than a three-layer appliance.

87. Here, a POSITA would not understand thin interfacial adhesives between soft and hard polymer layers to be their own “polymer layers.” This understanding is also reflected in the ’613 patent specification, which does not identify the interfacial layers from coextrusion (or that can be used during certain adhesive lamination techniques) as distinct “polymer layers.” The ’613 patent specification states that hard layers may be coextruded or laminated together, and

that soft layers may be laminated together. EX1001, 5:51-54, 6:32-64. The specification labels and identifies these polymer layers in Figure 2. EX1007 (Opening Declaration), ¶135, 140 ('613, '384, '090, '091 IPR). But the specification never identifies the coextruded interfacial layers or any other interfaces between laminated layers as distinct polymer layers.

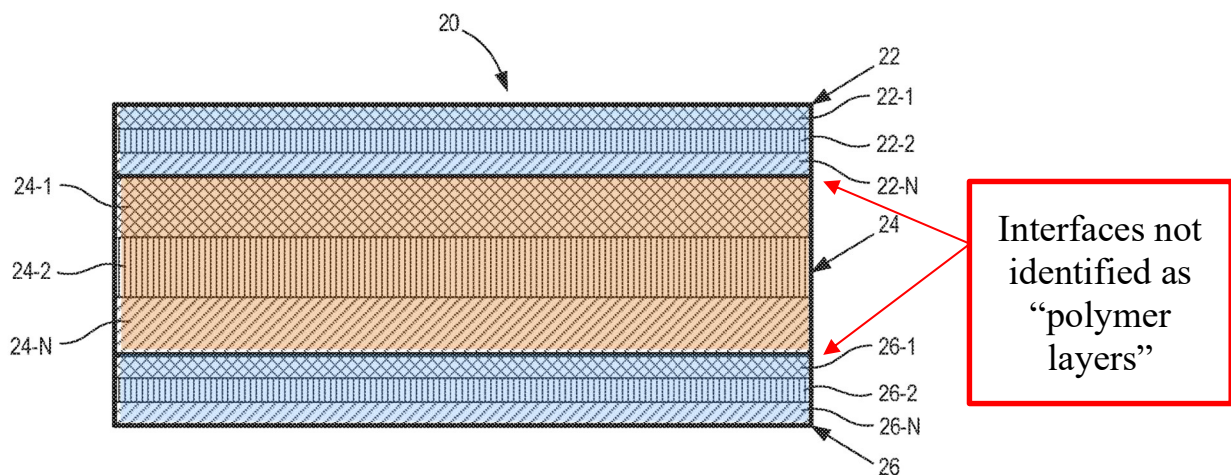


FIG. 2

EX1001, Fig. 2 (annotated). Dr. Kimmel's proposal, however, is to do exactly that, by counting the interfaces of a laminated appliance (like those shown in Fig. 2) as distinct "polymer layers." See EX2014 (Kimmel Declaration), ¶122. Dr. Kimmel's opinion is thus inconsistent with the '613 patent specification and testimony of Align's named inventor.

88. Dr. Kimmel's opinions are also problematic because they disregard interfacial layers when he chooses (e.g., with respect to Align's SmartTrack) while

counting them as layers at other times. He thus takes a subjective, inconsistent approach to interfacial layers in multilayer sheets and appliances.

89. Dr. Kimmel's opinions are also technically inaccurate. The inclusion of an extremely thin adhesive interlayer does not eliminate the presence of the substantially thicker structural polymer layers, nor does it negate their functional arrangement. EX1007 (Opening Declaration), ¶40 ('613, '384, '090, '091 IPR) (citing EX1042, 3-4). In multilayer polymer engineering, adhesive or tie layers are routinely used to bond dissimilar polymers without altering the primary mechanical role of the structural layers, including their designed flexural modulus and thermoforming behavior. EX1007 (Opening Declaration), ¶40 ('613, '384, '090, '091 IPR). That is, the adhesive interlayer serves as a bonding interface and does not redefine the identity or function of the principal load-bearing layers. *Id.* That is why a POSITA would not have counted the thin amount of adhesive between structural layers, which does not contribute to the multilayer sheet's properties, as a "layer" within the meaning of Align's patents.

90. The lack of structural contribution of such adhesives is confirmed by *Ebnesajjad*, which notes that "a feature of adhesives is the relatively small quantities (also thickness) that are required relative to the weight of the final objects." EX1042, 15. *Ebnesajjad* also defines particular adhesives as nonstructural, explaining "[n]onstructural adhesives are not required to support substantial loads but merely

hold lightweight materials in place.” EX1042, 3. This establishes that bulk mechanical properties, such as modulus and strength, are attributes of the structural layers, with the adhesive layer playing no meaningful role in determining them.

91. Dr. Kimmel’s reliance on Figure 21 from *Schrenk* as purportedly showing what such adhesive layers would look like is misplaced. EX2014 (Kimmel Declaration), ¶ 121. *Schrenk* explains that Figure 21 shows unique “sophisticated structures” wherein thick layers of polymers are used to provide “specific functional” properties to the composite. EX1019, 161-162. However, the proposed obviousness combinations use “basic” adhesive lamination processes with thin interfacial adhesives where the glue would not be expected to alter the functional properties of the composite. EX1007 (Opening Declaration), ¶¶40-41 (’613, ’384, ’090, ’091 IPR). The distinction between the proposed obviousness combinations and the excerpt from *Schrenk* is readily apparent when comparing the thickness of the glue in *Schrenk*’s Figure 21, which is thicker than the other functional polymer layers of PE and Saran, with the thin red lines of glue Dr. Kimmel superimposed onto the figure of the obviousness combination from my declaration. EX2014 (Kimmel Declaration), ¶¶121-122. A POSITA would not understand thin nonstructural adhesives to be “polymer layers.”

VII. Conclusion

92. For the reasons set forth above, it is still my opinion, as set forth in my opening declaration, that all of the challenged claims of the '613, '384, '090, and '091 patent would have been obvious to a person of ordinary skill in the art as of the patents' earliest possible priority date.

93. I reserve the right to offer opinions relevant to the invalidity of the claims at issue or offer testimony in support of this declaration.

94. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in this case, and that any cross-examination will take place in the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

95. I declare under penalty of perjury under the laws of the United States that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Date: May 29, 2026



Dr. Tim A. Osswald

Appendix A

In addition to the materials considered in my Opening Declaration (EX1007, Appx. A), I have considered the following in response to Dr. Kimmel's and Ms. Chen's declarations (EX2014, EX2016):

- EX1149 - Transcript of Deposition of Dr. Robert Kimmel (April 17, 2026)
- EX1151 - U.S. Patent Application Publication No. US 2012/0322951 (filed June 17, 2011) ("Eastman")
- EX1154 - P. Yue et al., *Phase-field simulations of interfacial dynamics in viscoelastic fluids using finite elements with adaptive meshing*, 219 J. COMPUTATIONAL PHYSICS 47 (2006)
- EX1155 - J.K. Kim & C.D. Han, *Polymer-Polymer Interdiffusion During Coextrusion*, 31 POLYMER ENGINEERING AND SCIENCE 258 (1991)
- EX1158 - Z. Zhang et al., *Melt-spun poly(ethylene terephthalate-co-1,4-cyclohexanedimethylene terephthalate) (PETG) copolyester fibers: Synergistic effect of chemical and crystal structure regulation*, 65 POLYMER ENGINEERING AND SCIENCE 755 (2024)
- EX1160 - C. Berti et al., *Poly(1,4-cyclohexylenedimethylene 1,4-cyclohexanedicarboxylate): Influence of Stereochemistry of 1,4-Cyclohexylene Units on the Thermal Properties*, 46 J. POLYMER SCIENCE 619 (2008)
- EX1161 - HARRY R. ALLCOCK & FREDERICK W. LAMPE, CONTEMPORARY POLYMER CHEMISTRY (2d ed. 1990) (excerpt)
- EX1163 - U.S. Patent No. 7,210,926 (filed Nov. 10, 2003)
- EX1164 - U.S. Patent No. 4,826,420 (filed Dec. 14, 1987)
- EX1165 - S.R. Morris & C.T. Sunt, *Analysis of Forming Loads for Thermoplastic Composite Laminates*, 27 COMPOSITES 633 (1996)
- EX1166 - G. Latini et al., *DI-2-Ethylhexyl Phthalate and Endocrine Disruption: A Review*, 4 ENDOCRINE, METABOLIC & IMMUNE DISORDERS - DRUG TARGETS 37 (2004)
- EX2014 - Declaration of Dr. Robert Kimmel
- EX2015 - Curriculum Vitae of Dr. Robert Kimmel
- EX2016 - Declaration of Yan Chen (Public)
- EX2017 - Osswald Deposition Transcript

- EX2019 - Daniel J. Brunelle et al., “Optimization of poly(1,4-cyclohexylidene cyclohexane-1,4-dicarboxylate (PCCD) preparation for increased crystallinity,” 47(11) Polymer 4094 (2006)
- EX2020 - James L. Throne, Understanding Thermoforming, Ch. 11 (2008)