

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NANOCO TECHNOLOGIES, LTD.,
Petitioner,

v.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
Patent Owner.

Case IPR2015-00528
Patent 6,322,901 C1

Before DONNA M. PRAISS, LYNNE E. PETTIGREW, and
JO-ANNE M. KOKOSKI, *Administrative Patent Judges*.

PRAISS, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

Nanoco Technologies, Ltd. (“Petitioner”) filed a Petition (Paper 2, “Pet.”) to institute an *inter partes* review of claims 1–21,¹ 24, 31–33, 35–45, and 47–50 of U.S. Patent No. 6,322,901 C1 (“the ’901 patent”) pursuant to 35 U.S.C. §§ 311–319. Massachusetts Institute of Technology (“Patent Owner”) timely filed a Preliminary Response (Paper 5, “Prelim. Resp.”). Taking into account the arguments presented in Patent Owner’s Preliminary Response, we determined that the information presented in the Petition established a reasonable likelihood that Petitioner would prevail in challenging claims 1, 2, 4, 6–14, 16, 18–20, 24, 31–33, 35–44, and 47–50 of the ’901 patent under 35 U.S.C. §§ 102(a) and 102(b). Pursuant to 35 U.S.C. § 314, we instituted this proceeding on July 27, 2015 as to these claims of the ’901 patent. Paper 6 (“Dec. on Inst.”).

Patent Owner timely filed a Patent Owner Response (Paper 9, “PO Resp.”) and Petitioner timely filed a Reply to the Patent Owner Response (Paper 10, “Pet. Reply”). An oral hearing was held on April 20, 2016, and a transcript of the hearing is included in the record. Paper 16 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6(c). This decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of claims 1, 2, 4, 6–14, 16, 18–20, 24, 31–33, 35–44, and 47–50 of the ’901 patent.

I. BACKGROUND

A. *Related Proceedings*

The ’901 patent was the subject of *Nanosys, Inc. v. Nanoco Technologies Ltd. and Sigma-Aldrich Co.*, Civil Action No. 3:9-cv-258-DF (W.D. Wis.), which was voluntarily dismissed with prejudice. Pet. 5; Paper

¹ The Petition excludes claim 14 from the list of claims challenged on page 1, but includes claim 14 in the body of the Petition. See, e.g., Pet. 11–12.

3, 2; Ex. 2001, 191. It was also the subject of Reexamination Control No. 90/010,736, filed November 11, 2009, which resulted in a reexamination certificate issued June 5, 2012, confirming claims 1–31 and adding claims 32–50. Pet. 3–4; Paper 3, 3; Ex. 1001, Reexam Cert. In addition, Reexamination Control No. 95/001,248 was assigned to a request for reexamination of the '901 patent submitted on October 16, 2009 that was deemed incomplete. *See* Paper 3, 3.

B. The '901 Patent (Ex. 1001)

The '901 patent, titled “Highly Luminescent Color-Selective Nano-Crystalline Materials,” is directed to coated nanocrystals capable of light emission known as semiconductor nanocrystallites or quantum dots. Ex. 1001, Abstr., 1:18–28. More particularly, the invention is described as “highly luminescent ZnS-capped CdSe ((CdSe)ZnS) nanocrystallites having a narrow particle size distribution.” *Id.* at 4:9–12, 4:35–56. The synthesis of the (CdSe)ZnS quantum dots “may be applied in the preparation of a variety of known semiconductor materials” and “used to obtain monodisperse overcoated quantum dots with various combinations of nanocrystallite core and overcoating.” *Id.* at 4:50–52, 8:45–49. The core of the nanocrystallites is said to be “substantially monodisperse.” The Specification describes “monodisperse” as “a colloidal system in which the suspending particles have substantially identical size and shape” and, more specifically, the “monodisperse particles deviate less than 10% in rms² diameter in the core, and preferably less than 5% in the core.” *Id.* at 4:16–22.

² We understand “rms” to refer to root mean square or square root of the mean squared deviations of each measurement from the average diameter. *See* Ex. 2005, 27.

The overcoating of the nanocrystallites may comprise ZnY, “where Y=S, Se, and mixtures thereof uniformly deposited thereon,” and “may further comprise an organic layer on the nanocrystal outer surface.” *Id.* at 2:49–50, 2:65–3:1. “The organic layer may be comprised of moieties selected to provide compatibility with a suspension medium, such as a short-chain polymer terminating in a moiety having affinity for a suspending medium, and moieties which demonstrate an affinity to the quantum dot surface.” *Id.* at 3:1–6. The affinity for the nanocrystal surface is said to promote “coordination of the organic compound to the quantum dot outer surface,” while the affinity for the suspension medium is said to “stabilize[] the quantum dot suspension.” *Id.* at 3:6–9.

C. Illustrative Claim

Independent claim 1 is illustrative of the claims at issue:

1. A coated nanocrystal capable of light emission, comprising:

a core comprising a first semiconductor material, said core being a member of a monodisperse particle population; and

an overcoating uniformly deposited on the core comprising a second semiconductor material,

wherein the first semiconductor material and the second semiconductor material are the same or different,

and wherein the monodisperse particle population is characterized in that when irradiated the population emits light in a spectral range of no greater than about 60 nm full width at half max (FWHM).

Ex. 1001, 11:9–21.

Each of independent claims 10, 32, and 44 also recites, *inter alia*, “an overcoating uniformly deposited on the core comprising a second semiconductor material” and that “the first semiconductor

material and the second semiconductor material are the same or different.”

The claimed “monodisperse particle population” is characterized in claim 10 “in that it exhibits no more than about a 10% rms deviation in the diameter of the core.” Claims 32 and 44 require that “the coated nanocrystal emits light in a narrow spectral range selected from blue light, green light, yellow light, orange light, or red light.” Ex. 1001, Reexam Cert. 1:33–36. Claim 44 also requires that “the coated nanocrystal exhibits photoluminescence having a quantum yield of greater than 30%[.]” *Id.* at Reexam Cert. 2:27–29.

D. The Grounds

We instituted this proceeding based on the asserted grounds of unpatentability (“grounds”) set forth in the table below. Dec. on Inst. 32.

Claims	Basis	Reference
1, 2, 4, 6, 13, 14, 16, 24, 31, 32, 35–41, 43, 44, and 47–50	102(a)	Peng ³
1, 2, 6–14, 16, 18–20, 24, 31–33, 35–39, and 41–43	102(b)	Murray ⁴

E. Claim Interpretation

As a first step in our analysis, we determine the meaning of the claims using the “broadest reasonable construction in light of the specification of

³ Peng et al., *Epitaxial Growth of Highly Luminescent CdSe/CdS Core/Shell Nanocrystals with Photostability and Electronic Accessibility*, 119 J. AM. CHEM. SOC. 7019–29 (1997) (Ex. 1010) (“Peng”).

⁴ Murray et al. *Synthesis and Characterization of Nearly Monodisperse CdE (E = S, Se, Te) Semiconductor Nanocrystallites*, 115 J. AM. CHEM. SOC. 8706–15 (1993) (Ex. 1007) (“Murray”).

the patent in which [they] appear[.]” 37 C.F.R. § 42.100(b); *see also* *Cuozzo Speed Techs., LLC v. Lee*, No. 15–446, 2016 WL 3369425 at *12 (U.S. June 20, 2016) (“We conclude that [37 C.F.R. § 42.100(b)] represents a reasonable exercise of the rulemaking authority that Congress delegated to the Patent Office.”). Under that standard, claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art⁵ in the context of the entire disclosure. *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

Petitioner proposes constructions for the claim terms “monodisperse particle population,” “wherein the first semiconductor material and the second semiconductor material are the same or different,” and “an overcoating uniformly deposited on the core,” which are recited in the independent claims, as well as “short-chain polymer terminating in a moiety having affinity for a suspension or dispersion medium,” which is recited in dependent claim 21. Pet. 6–10. Patent Owner proposes to adopt the Board’s interpretations of these terms in the Decision on Institution (PO Resp. 6) and contends that the “spectral range selected from blue light, green light, orange light or red light” recited in claims 32 and 44 is not a Markush grouping as Petitioner contends, but, rather, “a recitation of species that have to be available for selection.” *Id.* at 7–8. We address each of the proposed claim constructions below.

⁵ It is undisputed that a person of ordinary skill in the art “would typically have an advanced degree (i.e., a Masters or Ph.D.) in chemistry, materials science, or a related discipline.” Pet. 10 (citing Ex. 1002 ¶ 6); PO Resp. 6.

1. Monodisperse Particle Population

In our Decision to Institute, we determined that the claim term “monodisperse particle population” does not require construction because it is defined within the context of the independent claims. Dec. on Inst. 8–9. Specifically, we determined that the term is defined as “characterized in that when irradiated the population emits light in a spectral range of no greater than about 60 nm full width at half max (FWHM)” (claim 1) or “characterized in that it exhibits no more than about a 10% rms deviation in the diameter of the core” (claims 10, 32, and 44). *Id.* at 9. We remain of the view, based on the record developed at trial, that the term does not require a construction.

2. Wherein the First and Second Semiconductor Material are the Same

Petitioner proposes that when the first and second semiconductor materials are the same, the claim term is “properly construed as including nanocrystals comprising only a single semiconductor material.” Pet. 9. In support, Petitioner directs us to the claim construction of the same term during reexamination of U.S. Patent No. 6,861,155 C1 (“the ’155 patent”).⁶ *Id.* (citing Ex. 1003, 1100–01). Patent Owner does not dispute the proposed construction of this claim term. PO Resp. 6. In the Decision on Institution, we determined the plain meaning of the claim term “wherein the first . . . and the second semiconductor material are the same” encompasses nanocrystals comprising only a single semiconductor material. Dec. on Inst. 9. We see no reason, based on the trial record, to modify the interpretation of this term.

⁶ The ’155 patent claims priority to the ’901 patent through continuation and continuation-in-part applications. Ex. 1003, 1.

3. *An Overcoating Uniformly Deposited on the Core*

Petitioner proposes that “uniformly deposited” should be construed to “encompass any overcoating” because dependent claims 26 and 27 limit the overcoating recited in both independent claims 1 and 10 to “0 to about 5.3 monolayers” and “less than about one monolayer,” respectively. Pet. 9–10. In the Decision on Institution, we indicated we were not persuaded by Petitioner’s argument that the phrase “overcoating uniformly deposited,” which is recited in each independent claim of the ’901 patent, has no structural meaning. Dec. on Inst. 10. We found that dependent claim 26 does not limit “uniformly deposited” to a coating of zero as asserted by Petitioner. *Id.*; compare Pet. 9 (“claims 26 and 27 . . . further limit the overcoating to ‘0 to about 5.3 monolayers’ (Claim 26) . . .”) with Ex. 1001, 12:43–45 (“wherein the overcoating comprises *greater than about 0* to about 5.3 monolayers of the second semiconductor material.”) (emphasis added). We also adopted the ordinary definition of “uniformly” in construing this claim term, namely, “identical or consistent, as from example to example, place to place, or moment to moment,” and “without variations in detail.” Dec. on Inst. 10–11 (citing Ex. 3001). Based on the trial record, we see no reason to modify our claim construction of “an overcoating uniformly deposited on the core” as a structural component that is deposited on the core uniformly, i.e., without variation in detail.

4. *Short-Chain Polymer Terminating in a Moiety Having Affinity for a Suspension or Dispersion Medium*

Petitioner proposes that “short-chain polymer terminating in a moiety having affinity for a suspension or dispersion medium,” as recited in dependent claim 21, should be construed as it was during the reexamination of the ’155 patent to mean “any polymer-coated nanocrystal having an

affinity for a suspending medium.” Pet. 8 (citing Ex. 1003, 1461–62). In the Decision on Institution, we adopted Petitioner’s proposed claim construction that “short-chain polymer terminating in a moiety having affinity for a suspension or dispersion medium” means “any polymer-coated nanocrystal having an affinity for a suspending medium.” Dec. on Inst. 11–12. On the complete record after trial, we see no reason to modify the claim construction of this term.

5. The Coated Nanocrystal Emits Light in a Narrow Spectral Range Selected From Blue Light, Green Light, Yellow Light, Orange Light, or Red Light

Patent Owner asserts that “the coated nanocrystal emits light in a narrow spectral range selected from blue light, green light, yellow light, orange light, or red light,” as recited in independent claims 32 and 44, “is a recitation of species that have to be available for selection.” PO Resp. 8. Patent Owner’s reasoning is that a spectral range “can only be ‘selected’ among ‘blue light, green [light,] orange light or red light’ if the entire spectral range includes blue light, green light, orange light or red light [as] available options.” *Id.* at 7–8. Patent Owner asserts “the claim language does not refer to a Markush grouping.” *Id.* at 8 (citing MPEP § 803.02 (“A Markush-type claim recites alternatives in a format such as ‘selected from the group consisting of A, B and C.’”)). Patent Owner further asserts that its claim construction is consistent with the ’901 patent specification because “the claimed nanocrystal must belong to a monodisperse particle population such that when the population is irradiated, the coated nanocrystal is able to emit a spectral range **including** blue, green, yellow, orange or red light.” *Id.* at 9 (quoting Ex. 1001, 8:3–6 (“As the size of the CdSe core increased, the

color of the luminescence shows a continuous progression from the blue through the green, yellow, orange to red.”)).

Petitioner responds that “the claim recites a list of alternatives which, if it is not a formal Markush group, has the same meaning as a Markush group.” Pet. Reply 4; *id.* at 6 (quoting MPEP § 2173.05(h) (“Alternative Limitations . . . Alternative expressions are permitted if they present no uncertainty or ambiguity with respect to the question of scope or clarity of the claims. A ‘Markush’ claim recites a list of alternatively useable species. A Markush claim is commonly formatted as: ‘selected from the group consisting of A, B, and C;’ however, the phrase ‘Markush claim’ means any claim that recites a list of alternatively useable species regardless of format.”) (internal citations omitted)). Petitioner also asserts that the plain and ordinary meaning of the claim language is a list of alternatives because no specialized meaning was attributed to it. *Id.* at 5–11 (citing *Abbott Labs. v. Baxter Pharm. Prods., Inc.*, 334 F.3d 1274, 1281 (Fed. Cir. 2003); *Schumer v. Lab. Comput. Sys.*, 308 F.3d 1304, 1311–12 (Fed. Cir. 2002); *Kustom Signals, Inc. v. Applied Concepts, Inc.*, 264 F.3d 1326, 1330–31 (Fed. Cir. 2001)). Petitioner further asserts that the claims are directed to a nanocrystal, rather than a population of nanocrystals, and that “any given nanocrystal/quantum dot—being of a specific size—can emit light in only one spectral range” because the color of the light emitted is a function of size. *Id.* at 15 (citing Ex. 1001, 8:3–6).

After fully considering the parties’ arguments and the trial record, we agree with Petitioner that the plain meaning of the claim language “the coated nanocrystal emits light in a narrow spectral range selected from blue light, green light, yellow light, orange light, or red light” is a list of

alternatively useable species. Most significant to our analysis is the context of the claims themselves, namely, (1) a single coated nanocrystal is claimed, and (2) the spectral range comprises a list of light colors grouped together with the alternative contraction “or.” Patent Owner concedes that the claim is to a single nanocrystal, not to a population of nanocrystals. Tr. 26:7–12. The Specification is clear that light emission is dependent on the size of a particle. Ex. 1001, 8:3–6. Therefore, consistent with the Specification, the claimed single nanocrystal can only emit light in one color spectrum.

We are not persuaded that the claims require the recited “monodisperse particle population,” of which the single nanocrystal is a member, to possess the capability of emitting light in each of the spectral ranges listed in the claim. The claim language that precedes the list of spectral ranges specifies that it is the coated nanocrystal that emits light in the selected range, not the population of nanocrystals. We also are not persuaded that the word “or” should be construed as “and/or” and that such a construction would mean “the spectral range is for the population of nanocrystals” as Patent Owner argues. See Tr. 25:8–15. Patent Owner’s suggestion does not alter the language that precedes the list of ranges, it does not remove the alternative nature of the word “or,” and it would have us introduce ambiguity by further including the conjunction “and.” See William Strunk, Jr. & E. B. White, *THE ELEMENTS OF STYLE* 40 (4th ed. 2000) (“**And/or.** A device, or shortcut, that damages a sentence and often leads to confusion or ambiguity.”). For the reasons provided by Petitioner and discussed above, we construe the claim term to mean “a coated nanocrystal that emits light in a narrow spectral range that is any one of blue

light, green light, yellow light, orange light, or red light.” See Pet. Reply 4–15.

II. ANALYSIS

A. *Anticipation by Peng*

In our Decision to Institute, we instituted trial against claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 32, 35–41, 43, 44, and 47–50, determining that Petitioner was likely to prevail in showing the unpatentability of each of these claims as anticipated by Peng under 35 U.S.C. § 102(a). Dec. on Inst. 32.

Petitioner must demonstrate by a preponderance of the evidence that the challenged claims are unpatentable to prevail. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

1. *Claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 41, and 43*

Once trial was instituted, and after a specified period of discovery, Patent Owner was afforded the opportunity to file a Patent Owner Response to address “any ground for unpatentability not already denied” by our Decision on Institution. 37 C.F.R. § 42.120. In its Patent Owner Response, Patent Owner only addresses this ground as instituted against claims 32, 44, and their dependent claims, and is silent on the ground as instituted against claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 41, and 43. PO Resp. 2, 9.

Our Scheduling Order in this case cautioned Patent Owner “that any arguments for patentability not raised in the [Patent Owner Response] will be deemed waived.” Paper 7, 3. The Board’s Trial Practice Guide also states that the Patent Owner Response “should identify all the involved claims that are believed to be patentable and state the basis for that belief.” Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,766 (Aug. 14, 2012). Furthermore, as the Board has stated, our governing statute and

Rules “clearly place some onus on the patent owner, once trial is instituted, to address the material facts raised by the petition as jeopardizing [the] patentability of the challenged claims.” *Johnson Health Tech Co. Ltd. v. ICON Health & Fitness, Inc.*, Case IPR2013-00463, slip op. at 12 (PTAB Jan. 29, 2015) (Paper 41).

Here, Patent Owner does not articulate in the Patent Owner Response any reasons supporting the patentability of claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 41, and 43 over Peng on which we instituted trial. *See* PO Resp. 2, 7–10. In the absence of any response addressing the patentability of claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 41, and 43, Patent Owner effectively precluded Petitioner from replying any further to the merits of those eleven claims. *See* 37 C.F.R. § 42.23(b) (“A reply may only respond to arguments raised in the corresponding opposition or patent owner’s response.”). Petitioner relied on Patent Owner’s silence with respect to the unaddressed claims, and in its Reply only addresses “the issues Patent Owner raised in its Response.” Pet. Reply 2; *see also* Tr. 6:12–18 (Petitioner argues that “Patent Owner’s response only addressed independent claims 32 and 44 and their dependent claims. Therefore, the Patent Owner never rais[ed] the arguments as to any of the other claims as to Peng” and “has waived its argument as to those claims it did not address in the Patent Owner’s response.”). Nevertheless, Patent Owner asserts in the last sentence of its Response that “the Board should find that the challenged claims of the ’901 Patent are patentable.” PO Resp. 13.

By instituting trial, we determined that Petitioner presented credible evidence pointing towards the unpatentability of claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 41, and 43. Dec. on Inst. 21–23. Rather than address the evidence

applied against those challenged claims, Patent Owner chose to forego the opportunity, provided by statute, to present rebuttal evidence and/or argument on the issue of the patentability of those claims. Absent any rebuttal, we will not scour the record to locate evidence supporting patentability. Perfunctory or undeveloped arguments are waived. Thus, we are left to consider only the evidence of record as presented in the Petition. *See* Pet. 36–41. After considering Petitioner’s evidence with respect to claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 41, and 43, we find that Petitioner has shown, by a preponderance of the evidence, that these claims are unpatentable for the reasons provided in the Petition and below. *Id.*

Regarding claim 1, Petitioner contends that Peng discloses the synthesis of nanocrystals having “nearly monodisperse” cores of CdSe and an overcoating of CdS that “was shown to be uniform and epitaxial by X-ray photoelectron spectroscopy (XPS).” *Id.* at 37 (citing Ex. 1010, Abstr., 2). According to Petitioner, Figure 3 of Peng illustrates the photoluminescence of the nanoparticles and that the “curve has a FWHM of about 33 nm.” *Id.* (citing Ex. 1010, Fig. 3; Ex. 1002 ¶ 31). Paragraph 31 of the Hines Declaration describes the relationship between nanometers (nm) as used in claim 1, and electron volts (eV) as used in Figure of 3 of Peng, to illustrate photoluminescence of the nanocrystals. Using that relationship between eV and nm in the method for calculating FWHM, Dr. Hines “determined that the top photoluminescence curve of Figure 3A has a FWHM of about 33 nm.” Ex. 1002 ¶ 31; *see* Ex. 1002 ¶ 13.

We detect no defect in the calculations presented by Dr. Hines in the cited paragraph and, given Dr. Hines’s qualifications and experience (Ex. 1002 ¶¶ 3–4, Appendix A), we credit her testimony on the issue of the

photoluminescence of the nanocrystals disclosed by Peng. Therefore, the Petition adequately shows that Peng teaches nanocrystals with a uniform coating that functions within the narrow spectral range required by claim 1. *See* Ex. 1001, 2:50–54 (“an overcoating . . . uniformly deposited thereon, said coated core characterized in that when irradiated the particles emit light in a narrow spectral range of no greater than about 40 nm” at FWHM).

Regarding dependent claims 2, 4, 6, and 43, Peng discloses the emission of light at 33 nm at FWHM, which is not greater than about 40 nm FWHM as required by claim 2 and not greater than about 37 nm FWHM as required by claim 43. *See* Pet. 37–38 (citing Ex. 1010, Fig. 3; Ex. 1002 ¶ 31); *id.* at 41. Peng also discloses a quantum yield of at least 50%, which is a quantum yield greater than 30% as required by claim 4. *Id.* at 38 (citing Ex. 1010, Abstr., Fig. 3, 4). In addition, Peng discloses photoluminescence spectra that the Hines Declaration correlates to a range overlapping the range of about 470 nm to about 620 nm required by claim 6. *Id.* (citing Ex. 1010, Fig. 3; Ex. 1002 ¶ 31).

Regarding dependent claims 13, 14, and 16, Figure 3 of Peng discloses the claimed number of monolayers of the second semiconductor material. *Id.* at 39. Peng further discloses CdS as the overcoating or second semiconductor material as required by claim 24. *Id.* at 40 (citing back to contentions for claim 1 and Ex. 1010, Abstr.). Because the coated nanocrystal of Peng meets the requirements for a monodisperse particle population as discussed above in connection with claim 1, it also meets the requirements of claim 31. *Id.* Peng also discloses nanocrystals that are crystalline and, therefore, meets the requirements of claim 41. *Id.* at 41 (citing Ex. 1010, 9).

2. *Claims 32, 35–40, 44, and 47–50*

Claims 32 and 44 are independent and include all of the limitations of claim 1. *Compare* Ex. 1001, 11:9–21, *with id.*, Reexam Cert. 1:21–33, 2:16–28. Claims 32 and 44 recite the additional limitation “and the coated nanocrystal emits light in a narrow spectral range selected from blue light, green light, yellow light, orange light, or red light.” Ex. 1001, Reexam Cert. 1:33–36, 2:30–33. Petitioner asserts that Peng discloses photoluminescence spectra that range from 560 nm to 650 nm, which wavelengths the Hines Declaration explains are green light and red light, respectively, as required by claim 32. Pet. 40; Ex. 1010, Fig. 3; Ex. 1002 ¶¶ 31, 19. Claim 44 further recites “wherein the coated nanocrystal exhibits photoluminescence having a quantum yield of greater than 30%.” Ex. 1001, Reexam Cert. 2:28–30. Petitioner directs us to Peng’s reported quantum yield of at least 50%, which is a quantum yield greater than 30% as required by claim 44. Pet. 41, 37–38 (citing Ex. 1010, Abstr., Fig. 3, 4).

Patent Owner contends that claims 32 and 44 are only met “if the entire spectral range includ[ing] blue light, green light, orange light or red light are available options.” PO Resp. 7–8 (citations omitted). Patent Owner argues that the claim language is not a Markush group, but, rather, “a recitation of species that have to be available for selection.” *Id.* at 8. Patent Owner references Figure 3 and the associated description to illustrate this point. *Id.* at 8–9; Ex. 1001, 7:63–8:11. Patent Owner does not separately argue for the patentability of claims 35–40 and 47–50, which depend from claims 32 and 44, respectively. *See* PO Resp. 7–10.

Petitioner responds that the limitation “the coated nanocrystal emits light in a narrow spectral range selected from blue light, green light, yellow

light, orange light, or red light” is either a Markush group or has “exactly the same meaning.” Pet. Reply 5–9. Petitioner cites *Abbott Labs.*, 334 F.3d at 1280, as authority that the “alternative” phrasing in claims 32 and 44 constitutes a proper Markush group and asserts that any one of the colors in the prior art anticipates the claim. *Id.* at 5–7. Petitioner also contends that even if the language is not interpreted as a formal Markush group, the plain and ordinary meaning of the language is the same because it is simply a list of alternatives. *Id.* at 7–9. Petitioner further argues, “each of the samples in Figure 3 represents a different size core, with each sample accordingly emitting in only a single spectral range.” *Id.* at 15. The ’901 specification notes that the frequency of the emitted light corresponds to the band gap of the semiconductor material, which is a function of crystal size. *Id.* at 14–15 (citing Ex. 1001, 4:23–29). Because the claims are directed to a single coated nanocrystal and not multiple different nanocrystals of differing sizes, the claimed nanocrystal can emit light in only one color. *Id.* Petitioner also characterizes Patent Owner’s discussion of claims 32 and 44 as requiring a product-by-process interpretation. *Id.* at 16–17.

For the reasons discussed in Section I.E.5., *supra*, we are persuaded that the broadest reasonable interpretation of the claimed narrow spectral range consistent with the specification is a list of alternatives. Even if the language in claims 32 and 44 does not constitute a proper Markush group, it lists a variety of narrow spectral ranges as colors that can be emitted by the claimed single nanocrystal; however, a particular nanocrystal is a particular size and, thus, emits only one of these alternative colors.

During the oral hearing, Patent Owner argued that the claimed nanocrystal is part of a population of nanocrystals. Tr. 25:8–27:5. In

particular, Patent Owner stated, “this nanocrystal is part of that population, and the population language is in the claim” and “the claim does include . . . monodisperse particle populations . . . [which] gives characteristics of the emission of the population.” *Id.* at 25:13–15, 26:9–16. The population to which the core in claims 32 and 44 belongs is “a monodisperse particle population.” Ex. 1001, Reexam Cert. 1:24–25. However, this population includes monodisperse particles of largely the same size that all emit one color of light in a narrow spectral range. “The core of the nanocrystallites is substantially monodisperse. By monodisperse, as that term is used herein, it is meant a colloidal system in which the suspended particles have substantially identical size and shape.” Ex. 1001, 4:16–20. As such, because claims 32 and 44 are directed towards a nanocrystal (from a population of similarly sized and shaped nanocrystals) which emits light in a single narrow spectral range of one of the listed colors, we are not persuaded that claims 32 and 44 require all of the alternative spectral ranges, and, implicitly, different nanocrystal sizes. Rather, the nanocrystals that comprise the claimed monodisperse particle population emit light of one color corresponding to one of the alternative narrow spectral ranges listed in the claim.

Further, we are not persuaded that the claims are product-by-process claims. The claims are directed to a nanocrystal that emits light in one of the alternative narrow spectral ranges. As noted above, we interpret the claim to indicate an alternative set of spectral ranges of light emitted by the nanocrystal, any one of which anticipates the claim. Even if the spectral range claim limitation introduces a process step into the claim, we are persuaded, for the reasons provided by Petitioner, that the product produced

thereby is anticipated by Peng. Pet. Reply 16–17 (citing *Amgen Inc. v. F. Hoffmann-La Roche, Ltd.*, 580 F.3d 1340, 1366 (Fed. Cir. 2009) (“If the product in a product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a difference process.”)).

In addition to disclosing the elements of claim 1, as discussed in Section II.A.1., *supra*, Peng discloses photoluminescence spectra that range from 560 nm to 650 nm, which wavelengths the Hines Declaration explains are green light and red light, respectively, as required by claim 32. Pet. 40; Ex. 1010, Fig. 3; Ex. 1002 ¶¶ 31, 19. Because the coated nanocrystal of Peng has photoluminescence spectra that include the particular colors of light required by claims 35–38 and 47–50, it meets the requirements of those claims as well. Pet. 41–42. Peng’s coated nanocrystal also meets all of the requirements of claims 40 and 44 because it has a quantum yield greater than 30%, as shown in the Petition with respect to claim 4. *Id.* at 41. The requirements of claim 39 also are met by Peng because Peng discloses nanocrystals that are crystalline. *Id.* (citing Ex. 1010, 9).

After considering all of Petitioner’s and Patent Owner’s arguments and evidence with respect to claims 32, 35–40, 44, and 47–50, we find that Petitioner has shown, by a preponderance of the evidence, that these claims are unpatentable for the reasons provided in the Petition and above.

B. Anticipation by Murray

In our Decision to Institute, we instituted trial against claims 1, 2, 6–14, 16, 18–20, 24, 31–33, 35–39, and 41–43 for anticipation by Murray under 35 U.S.C. § 102(b). Dec. on Inst. 32. Petitioner must demonstrate by

a preponderance of the evidence that the challenged claims are unpatentable to prevail. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

1. Independent Claims 1, 10, and 32

Among the claims that Petitioner asserts are anticipated by Murray, claims 1, 10, and 32 are independent. Regarding the independent claims, Petitioner asserts that Murray discloses semiconductor nanocrystallites of CdS, CdSe, or CdTe that are nearly monodisperse, having a size distribution of less than 5% rms. Pet. 43–47 (citing Ex. 1007, Title, Abstr., 4).

Petitioner further asserts that Murray’s bare nanocrystallites meet the alternative requirement in each of the independent claims that the first and second semiconductor materials are the same (rather than different) because “those claims read on a simple homogenous nanocrystal of a single semiconductor material.” *Id.* at 42–46 (citing Ex. 1002 ¶ 11). According to Petitioner, Murray also discloses an emission spectrum of 32 nm at FWHM, which is no greater than about 60 nm at FWHM as required by claim 1. *Id.* at 44 (citing Ex. 1007, 10, Fig. 5; Ex. 1002 ¶ 33). Because Murray teaches the size distribution of the nanocrystals is less than 5% rms, Petitioner asserts this requirement of claim 10 is also met. *Id.* at 45 (citing Ex. 1007, Abstr.). Petitioner also directs us to the emission spectrum illustrated in Figure 5 of Murray, which the Hines Declaration correlates to green light as recited in claim 32. *Id.* at 47 (citing Ex. 1007, Fig. 5; Ex. 1002 ¶¶ 19, 33).

As an initial matter, Patent Owner generally relies upon the same arguments made with regard to Peng to argue that Murray does not disclose “the coated nanocrystal emits light in a narrow spectral range selected from blue light, green light, yellow light, orange light, or red light” as recited in

claim 32.⁷ PO Resp. 10. For the same reasons discussed above, we are not persuaded by Patent Owner’s argument regarding this limitation.

Patent Owner further contends that Murray does not anticipate claims 1, 10–12, 18–20, and claims that depend therefrom, because it does not describe an “overcoating . . . comprising a second semiconductor material.” *Id.* Patent Owner asserts that even if the materials are the same, there is still a distinct “core” structure and a distinct “overcoating” structure based on the plain language of the claims. *Id.* at 11. Patent Owner further argues that the testimony of Petitioner’s expert Dr. Hines on the subject is conclusory, and that the figure included in the Hines Declaration “appears to agree” with the presence of “distinct” structures for the core and the overcoating when each is comprised of the same semiconductor material. *Id.* at 11, 12 (citing Ex. 1002 ¶ 11 (as “Ex. 1002, p. 10”)).

Petitioner responds that Patent Owner provides only “unsupported attorney argument” which “completely ignores—and is diametrically opposed to—Dr. Hines’ actual testimony[.]” Pet. Reply 18. Petitioner takes the position that because Patent Owner did not provide evidence to the contrary or cross-examine Dr. Hines, the instituted claims should be held unpatentable. *Id.* at 18–19; Tr. 14:1–14, 16:14–24.

Petitioner has the burden to establish by a preponderance of the evidence that Murray anticipates all limitations of claims 1, 10, and 32. It is undisputed that “the only evidence” of record regarding whether Murray’s

⁷ Patent Owner also argues that Murray cannot anticipate claim 44 for this same reason. PO Resp. 10. We did not institute trial against claim 44 as anticipated by Murray, therefore, we limit our discussion to claim 32. Dec. on Inst. 32.

naked nanocrystal is the same as a nanocrystal with “an overcoating uniformly deposited on the core” when the core and the coating comprise the same semiconductor material is paragraph 11 of the Hines Declaration. Pet. 42; Pet. Reply 17–19; Tr. 18:21–23.⁸ At oral hearing, Petitioner conceded that the only evidence to support Dr. Hines’s testimony regarding the presence or absence of an interface on a coated crystalline structure “may be in Dr. Hines’ paper and not in her declaration” showing an interface between a core and a coating when the semiconductor materials are different. Tr. 15:17–16:8 (“[T]here is a discussion of a lattice mismatch when you have crystalline structures that are different.”). The Hines Declaration is testimony of an employee of Petitioner. Ex. 1002 ¶1. No further evidence or explanation is provided by Dr. Hines on this issue in this proceeding apart from the statement in paragraph 11 that “if the first and second semiconductor materials are the same, then there is no interface.” *Id.* ¶ 11. Although we consider the testimony of Dr. Hines, we do not attribute much weight to it given her employment by Petitioner and the lack of objective evidence in support thereof.

As noted in our Decision to Institute, we are not persuaded that the phrase “overcoating uniformly deposited” has no structural meaning. Dec. on Inst. 10. Patent Owner pointed out at oral hearing that the claimed “overcoating is a noun . . . [i]t is a layer. It is a second layer that is

⁸ Petitioner additionally cites the reexamination record of related U.S. Patent 6,861,155 as evidence that an examiner recognized that when the materials are the same, the claim would cover a unitary nanocrystal. Pet. 42–43 (citing Ex. 1003, 1100). However, in the passage cited by Petitioner, the examiner is quoting the third party requester of the reexamination for this proposition. See Ex. 1003, 1100.

overcoating the core.” Tr. 23:1–4. We agree with Patent Owner that the claim requires a separate overcoating layer. Absent any objective evidence in this record that a uniform core is identical to a core with an overcoating layer when the semiconductor materials are the same, we are not persuaded that Murray discloses the recited “overcoating” required by each of the independent claims. The ’901 patent Specification incorporates by reference the teachings of Murray for forming “monodisperse CdSe quantum dots.” Ex. 1001, 6:22–25. The passage goes on to describe how the CdSe particles, such as Murray’s, are “overcoated.” *Id.* at 6:26–29. This suggests structurally modifying a core, such as Murray’s CdSe core, by adding an overcoating to it. The materials used to make both the core and the overcoating are broadly described as “a variety of known semiconductor materials.” *Id.* at 4:50–52.

In view of the complete trial record, we are not persuaded that Petitioner has established by a preponderance of the evidence that the claimed core and overcoating would not be structurally different from Murray’s uncoated “homogenous” core. Petitioner’s suggestion at the oral hearing that evidence of an interface when the core and the coating materials are different demonstrates that no interface occurs when the materials are the same is not sufficient, even if it were cited and properly relied upon in the Petition.

We conclude that Petitioner has not demonstrated by a preponderance of the evidence that Murray anticipates independent claims 1, 10, and 32.

2. Dependent Claims

Claims 2, 6–9, 11–14, 16, 18–20, 24, 31, 33, 35–39, and 41–43 each depend, directly or indirectly, from one of claims 1, 10, and 32. Because

Petitioner has failed to establish that Murray anticipates claims 1, 10, and 32, it follows that Petitioner also has failed to establish by a preponderance of the evidence that Murray anticipates claims 2, 6–9, 11–14, 16, 18–20, 24, 31, 33, 35–39, and 41–43.

C. Conclusion

Having fully considered the parties' contentions and supporting evidence, we are persuaded that Petitioner has demonstrated by a preponderance of the evidence that claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 32, 35–41, 43, 44, and 47–50 are unpatentable as anticipated by Peng under 35 U.S.C. § 102(a).

We are not persuaded that Petitioner has demonstrated by a preponderance of the evidence that claims 1, 2, 6–14, 16, 18–20, 24, 31–33, 35–39, and 41–43 are unpatentable as anticipated by Murray under 35 U.S.C. § 102(b).

III. ORDER

Accordingly, it is

ORDERED that claims 1, 2, 4, 6, 13, 14, 16, 24, 31, 32, 35–41, 43, 44, and 47–50 of U.S. Patent No. 6,322,901 C1 have been shown by a preponderance of the evidence to be unpatentable;

FURTHER ORDERED that Petitioner has not shown by a preponderance of the evidence that claims 7–12, 18–20, 33, and 42 of U.S. Patent No. 6,322,901 C1 are unpatentable; and

FURTHER ORDERED that this is a Final Written Decision, and parties to the proceeding seeking judicial review of this Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2015-00528
Patent 6,322,901 C1

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