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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/880,210	07/19/2007	Kai Sun	10762.0037-01	6359

22852 7590 06/09/2020

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER LLP
901 NEW YORK AVENUE, NW
WASHINGTON, DC 20001-4413

EXAMINER
PAYEN, MARVIN

ART UNIT	PAPER NUMBER
2816	

NOTIFICATION DATE	DELIVERY MODE
06/09/2020	ELECTRONIC

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UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Ex parte KAI SUN, FAN YANG, and STEPHEN R. FORREST

_____

Appeal 2019-004897
Application 11/880,210
Technology Center 2800

_____

Before MONTÉ T. SQUIRE, LILAN REN, and
JANE E. INGLESE, *Administrative Patent Judges*.

INGLESE, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant[1] requests our review under 35 U.S.C. § 134(a) of the Examiner's decision to finally reject claims 1 and 3–7.[2] We have jurisdiction over this appeal under 35 U.S.C. § 6(b).

We REVERSE.

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[1] We use the word "Appellant" to refer to the "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies The Trustees of Princeton University and The Regents of the University of Michigan as the real parties in interest. Appeal Brief filed July 20, 2018 ("Appeal Br.") at 1.

[2] Claims 8–14 have been withdrawn from consideration. Final Office Action entered June 22, 2017 ("Final Act.") at 1.

CLAIMED SUBJECT MATTER

Appellant claims a method of fabricating a photosensitive optoelectronic device. Appeal Br. 3–4. Claim 1, the sole pending independent claim, reads as follows:

> 1. A method of fabricating a photosensitive optoelectronic device, comprising:
>
> depositing a first organic semiconductor material over a first electrode to form a continuous first layer;
>
> *depositing a second organic semiconductor material over the first layer to form a discontinuous second layer, portions of the first layer remaining exposed;*
>
> *depositing the first organic semiconductor material directly on the second layer to form a discontinuous third layer, portions of at least the second layer remaining exposed;*
>
> *alternating deposition of the first and second organic semiconductor materials*;
>
> depositing the second organic semiconductor material to form a continuous fourth layer, and
>
> depositing a second electrode over the fourth layer,
>
> wherein at least one of the first electrode and the second electrode is transparent, and
>
> the first organic semiconductor material is one or more donor-type materials or one or more acceptor-type materials relative to the second organic semiconductor material, said second organic semiconductor material being one or more materials of the other material,
>
> wherein *at least one of the first and second organic semiconductor materials comprise nanocrystals*.

Appeal Br. 15 (Claims Appendix) (emphasis added).

REJECTIONS

The Examiner maintains the following rejections in the Examiner's Answer entered April 4, 2019 ("Ans."):

I. Claims 1 and 3–7 under 35 U.S.C. § 112, first paragraph for failing to comply with the enablement requirement; and

II. Claims 1 and 3–7 under 35 U.S.C. § 103(a) as unpatentable over Forrest et al. (US 2002/0119297 Al, published August 29, 2002) in view of Peumans et al. (US 2005/0061364 Al, published March 24, 2005).

FACTUAL FINDINGS AND ANALYSIS

Upon consideration of the evidence relied upon in this appeal and each of Appellant's contentions, we reverse the Examiner's rejection of claims 1 and 3–7 under 35 U.S.C. § 112, first paragraph for failing to comply with the enablement requirement, and rejection of claims 1 and 3–7 under 35 U.S.C. § 103(a) as unpatentable over Forrest in view of Peumans, for reasons set forth in the Appeal and Reply Briefs, and below.

Rejection I

We first address the Examiner's rejection of claims 1 and 3–7 under 35 U.S.C. § 112, first paragraph for failing to comply with the enablement requirement.

The entirety of the Examiner's enablement rejection as set forth in the Final Action states that "the applicant has illustrated numerous examples of prior/related art; however there is/are no clear and distinct figure/s of the claimed invention. Furthermore, the specification fails to make direct references to the claimed elements/features as it relates to the figures and in the context of claims 1, 5 and 6." Final Act. 5.

On the record before us, however, the Examiner does not establish that Appellant's Specification fails to teach those skilled in the art how to

make and use the full scope of the methods recited in claims 1, 5, and 6 without undue experimentation.

For an enablement rejection, the PTO must "set[] forth a reasonable explanation as to why it believes that the scope of protection provided by that claim is not adequately enabled by the description of the invention." *In re Wright*, 999 F.2d 1557, 1561–62 (Fed. Cir. 1993). "[T]o be enabling, the specification of a patent must teach those skilled in the art how to make and use the full scope of the claimed invention without 'undue experimentation.'" *Id.* at 1561. Some experimentation, even a considerable amount, is not "undue" if it is merely routine, or if the Specification provides a reasonable amount of guidance as to the direction in which the experimentation should proceed. *In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988).

The following factors are relevant in determining whether undue experimentation would be required to make and use a claimed invention: "(1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims." *Id.* It is not necessary for an Examiner to review all of the *Wands* factors, as long as it is evident that the Examiner's analysis is at least reasonably based on some of the factors. *In re Hillis*, 484 Fed. App'x 491, 495 (Fed. Cir. 2012) (unpublished); *see also Amgen, Inc. v. Chugai Pharm. Co*., 927 F.2d 1200, 1213 (Fed. Cir. 1991) ("[I]t is not necessary that a court review all the *Wands* factors to find a disclosure enabling. They are illustrative, not mandatory.").

Appellant's Specification describes fabrication of a photosensitive optoelectronic device as recited in claim 1 in which the photoactive region comprises a nanocrystalline network of ultra-thin, alternating layers of donor and acceptor molecules, and layers that do not fully cover an underlying layer are sandwiched between two continuous layers. Spec. ¶¶ 18, 35, 63, 65. The Specification explains that formation of the discontinuous layers results from a combination of lack of surface wetting, and control of film morphology and crystalline texture using organic vapor phase deposition (OVPD). Spec. ¶ 63.

The Specification describes a process for forming such a nanocrystalline donor/acceptor network that involves first depositing a continuous and planar donor layer of copper phthalocyanine (CuPc) on a transparent conductive, indium-tin-oxide (ITO) substrate; adding a very thin accepter layer of C60 to the continuous donor layer that forms crystalline islands due to incomplete surface wetting and leaves a portion of the underlying CuPc layer exposed; and depositing a second, thin crystalline CuPc layer that partially covers the C60 and includes portions that directly contact the first, continuous CuPc layer. Spec. ¶ 64. The Specification explains that by "continuously alternating the deposition of C_{60} and CuPc, 3D interpenetrating nanocrystalline networks of C_{60} and CuPc are formed." *Id.*

The Specification further provides a detailed description of suitable organic vapor phase deposition conditions for fabricating such a photoactive region comprised of a nanocrystalline network of ultra-thin, alternating layers of donor and acceptor molecules, including suitable materials for each

layer, and suitable source temperatures, flow rates, reactor pressures, and growth times. Spec. ¶ 77.

The Specification also describes formation of an exciton blocking layer as recited in claim 5 (Spec. ¶¶ 37, 69; Figs. 2, 7, and 8), and formation of a second photoactive region as recited in claim 6 (Spec. ¶ 51; Figs. 7 and 8).

As Appellant points out (Appeal Br. 7), the Specification also incorporates U.S. patent application 11/561,448 by reference (Spec. ¶ 3), which includes Figures 9A–9G that illustrate fabrication of a photoactive region comprised of a nanocrystalline network of ultra-thin, alternating layers of donor and acceptor molecules. Application 11/561,448 ¶¶ 81, 82; Figs. 9A–9G. Specifically, Figure 9A illustrates deposition of first continuous donor layer 152, Figure 9B illustrates deposition of plural nanocrystals as first discontinuous layer 953a, Figure 9C illustrates deposition of plural nanocrystals of an acceptor material as second discontinuous layer 953b, Figure 9D illustrates deposition of plural nanocrystals of a donor material as third discontinuous layer 953c, Figure 9E illustrates deposition of plural nanocrystals as fourth discontinuous layer 953d, and Figure 9F illustrates deposition of continuous acceptor layer 154.

Although the Examiner need not address all of the *Wands* factors, the Examiner's enablement analysis must be based at least on some of the factors, as discussed above. The Examiner, however, does not discuss even a single *Wands* factor in setting forth the enablement rejection. Rather, the Examiner's rejection is based solely on an asserted lack of Figures that illustrate the features of claims 1, 5, and 6, and does not take into consideration the above disclosures in Appellant's Specification and

drawings, including Figures 9A–9G from application 11/561,448 (incorporated into Appellant's application). Final Act. 5; Ans. 3–4. The Examiner does not explain why, in light of this direction and guidance provided in the Specification, and given the state of the prior art, the relative skill of those in the art, and the predictability of the art, one of ordinary skill in the art would be unable to fabricate a photosensitive optoelectronic device according to the method steps recited in claims 1, 5, and 6 without undue experimentation. *Id.*

Consequently, the Examiner does not establish that the experimentation required for one of ordinary skill in the art to practice the full scope of the methods of claims 1, 5, and 6 would be undue. We, accordingly, do not sustain the Examiner's rejection of claims 1 and 3–7 under 35 U.S.C. § 112, first paragraph for failing to comply with the enablement requirement.

Rejection II

We turn next to the Examiner's rejection of claims 1 and 3–7 under 35 U.S.C. § 103(a) as unpatentable over Forrest in view of Peumans.

Claim 1 requires the recited method of fabricating a photosensitive optoelectronic device to comprise, in part, depositing a first organic semiconductor material over a first electrode to form a continuous first layer; depositing a second organic semiconductor material over the first layer to form a discontinuous second layer, so that portions of the first layer remain exposed; depositing the first organic semiconductor material directly on the second layer to form a discontinuous third layer, so that portions of at least the second layer remain exposed; and alternating deposition of the first and second organic semiconductor materials.

The Examiner finds that Figure 6 of Forrest discloses fabricating a photosensitive optoelectronic device by depositing first organic layer 603 over first electrode 602 to form a continuous first layer; depositing second organic layer 604 over the first layer to form a discontinuous second layer, so that portions of the first layer remain exposed; depositing the first organic semiconductor material directly on the second layer to form a discontinuous third organic layer 605, so that portions of at least the second layer remain exposed; and alternating deposition of the first and second organic semiconductor materials. Final Act. 6 (citing Forrest Fig. 6).

The Examiner finds that Forrest does not disclose that at least one of the first and second organic semiconductor materials are formed of nanocrystals. Final Act. 7. The Examiner finds, however, that Peumans discloses "at least one of the first and second organic semiconductor materials are formed of nanocrystals," and the Examiner concludes that "it would have been obvious to one of ordinary skill in the art at the time the invention was made, since techniques for forming organic semiconductor materials of nanocrystals are well-understood in the art." *Id.* (citing Peumans ¶¶ 43, 47).

On the record before us, however, the Examiner does not provide a sufficient factual basis to establish that a combination of the relied-upon disclosures of Forrest and Peumans would have suggested fabricating a photosensitive optoelectronic device according to a method having the features recited in claim 1.

Forrest explains that Figure 6 illustrates organic photosensitive optoelectronic cell 600 comprising substrate 601, first electrode 602 adjacent to substrate 601, first organic layer 603 adjacent to first electrode 602 and

comprising 3,4,9,10-perylenetetracarboxylic dianhydride (PTCDA), 3,4,9,10-perylenetetracarboxylicbis-benzimidazole (PTCBI), or copper phthalocyanine (CuPc); second organic layer 604 adjacent to first organic layer 603 and comprising 4,4-bis[N-(1-napthyl)-N-phenyl-amino]biphenyl (α-NPD); third organic layer 605 adjacent to second organic layer 604 and comprising aluminum tris(8-hydroxyquinoline) (Alq_3); fourth organic layer 606 adjacent to third organic layer 605 and comprising CuPc, PTCBI, or PTCDA; and second electrode 607 adjacent to fourth organic layer 606. Forrest ¶ 81; Fig. 6.

As Appellant argues (Appeal Br. 8–9), although the Examiner asserts that Forrest's second organic layer 604 forms a discontinuous second layer, so that portions of first organic layer 603 remain exposed, the Examiner does not identify any disclosure in Forrest that actually teaches or would have suggested that second organic layer 604 is discontinuous so that portions of first organic layer 603 remaining exposed. Similarly, although the Examiner also asserts that Forrest's third organic layer 605 forms a discontinuous third layer, so that portions of second organic layer 604 remain exposed, the Examiner does not identify any disclosure in Forrest that actually teaches or would have suggested that third organic layer 605 is discontinuous so that portions of second organic layer 604 remain exposed, as Appellant also points out (Appeal Br. 9–10).

Nor does the Examiner identify any actual disclosure in Forrest of alternating deposition of first and second organic materials, as recited in claim 1, as Appellant further points out (Appeal Br. 10–11). As discussed above, Forrest discloses that first organic layer 603 comprises 3,4,9,10-perylenetetracarboxylic dianhydride (PTCDA), 3,4,9,10-

perylenetetracarboxylicbis-benzimidazole (PTCBI), or copper phthalocyanine (CuPc); second organic layer 604 comprises 4,4-bis[N-(1-napthyl)-N-phenyl-amino]biphenyl (α-NPD); third organic layer 605 comprises aluminum tris(8-hydroxyquinoline) (Alq_3); and fourth organic layer 606 comprises CuPc, PTCBI, or PTCDA. The four organic layers illustrated in Figure 6 of Forrest, therefore, are not comprised of alternating layers of first and second organic materials.

Although the Examiner responds to Appellant's arguments in the Answer by finding—for the first time—that Figure 9 of Forrest illustrates "multiple first, second, third and fourth organic layers (903a-d, 904a-d, 905a-d and 906a-d) . . . and illustrates portions of the aforementioned layers remaining exposed" (Ans. 5), like Figure 6 of Forrest, Figure 9 does not illustrate discontinuous organic layers formed so that portions of one or more underlying layers remain exposed. Rather, Figure 9 of Forrest illustrates a stacked organic photosensitive optoelectronic device comprised of numerous multilayer organic photovoltaic sub-cells. Forrest ¶ 87. Figure 9 shows that a portion of second electrode 907a in the bottom-most sub-cell is exposed, but portions of underlying first 903a, second 904a, third 905a, and fourth 906a organic layers are not exposed. *Id.* Similarly, in the middle sub-cell, a portion of first electrode 902b is exposed, but portions of underlying first 903b, second 904b, third 905b, and fourth 906b organic layers are not exposed. *Id.* And in the top-most sub-cells, a portion of second electrode 907c is exposed, but portions of underlying first 903c, second 904c, third 905c, and fourth 906c organic layers are not exposed, and portions of overlaying first 903d, second 904d, third 905d, and fourth 906d organic layers are also not exposed. *Id.*

Thus, the Examiner does not identify any actual disclosure in Forrest that teaches or would have suggested that any of the organic layers in the organic photosensitive optoelectronic devices described in the reference are discontinuous, so that portions of one or more underlying organic layers remain exposed. Because the Examiner does not rely on Peumans[3] for any disclosure that remedies this deficiency in the Examiner's reliance on Forrest, we do not sustain the Examiner's rejection of claims 1 and 3–7 under 35 U.S.C. § 103(a) as unpatentable over Forrest in view of Peumans.

CONCLUSION

Claims	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1, 3–7	112, first paragraph	Enablement		1, 3–7
1, 3–7	103(a)	Forrest, Peumans		1, 3–7
Overall Outcome				1, 3–7

REVERSED

[3] We need not address the Examiner's reliance on Peumans in detail for disposition of this appeal.