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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL
AND APPEAL BOARD

Ex parte ARTHUR CORNFELD

Appeal 2015-001555
Application 13/836,742
Technology Center 1700

Before PETER F. KRATZ, BEVERLY A. FRANKLIN, and MICHAEL P. COLAIANNI, *Administrative Patent Judges*.

COLAIANNI, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant appeals under 35 U.S.C. § 134 the final rejection of claims 1--18. We have jurisdiction over the appeal pursuant to 35 U.S.C. § 6(b).

We AFFIRM.

Appellant's invention is directed to solar cells and fabrication of solar cells with the design and specification of the window layer in multi-junction solar cells based on III-V semiconductor compounds (Spec. ¶ 3).

Claim 1 is illustrative (emphasis added to highlight argued distinctions):

1. A multijunction solar cell comprising:

a surface layer;

an upper first solar subcell disposed below the surface layer and being composed of a semiconductor material having a first band gap, and the first solar subcell having a base region and an emitter region;

a window layer disposed directly over the emitter region of the upper first solar subcell and directly below the surface layer, the window layer having a increasing gradation in doping from the region in the window layer adjacent to the emitter region to the region in the window layer adjacent to the surface layer overlying the window layer so that minority carriers in the window layer experience an electric field which would tend to drive them in the direction of the emitter layer; and

a second solar subcell adjacent to said first solar subcell and having a second band gap smaller than the first band gap and being lattice matched with the upper first solar subcell.

Appellant appeals the following rejections:

1. Claims 1, 3, 6, and 14-16 are rejected under 35 U.S.C. § 103(a), as unpatentable over Newman et al., (US 2010/0229926 A1, published Sept. 16, 2010; hereinafter "Newman"); in view of Farmer et al., (US 2010/0218819 A1; published Sept. 2, 2010; hereinafter "Farmer") and Grillot et al., (US 7,951,693; issued May 31, 2011; hereinafter "Grillot").
2. Claims 2, 17, and 18 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot and Nie et al., (US 2012/0104460 A1, published May 3, 2012; hereinafter, "Nie").

3. Claims 4, 5, and 12 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, and Misra et al., (US 2012/0103403 A1; published May 3, 2012; hereinafter "Misra").
4. Claims 7 and 13 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, Virshup (US 5,342,451; issued Aug. 30, 1994), and Karam et al., (US 6,150,603; issued Nov. 21, 2000; hereinafter "Karam").
5. Claims 8 and 9 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, Fafard (US 7,863,516; issued Jan. 4, 2011) and as evidenced by Li, et al., *Unintentional Doping and Compensation Effects of Carbon in Metal-Organic Chemical-Vapor Deposition Fabriacated ZnO thin Films,* Journal of Vacuum Science and Technology A (2006); hereinafter "Li".
6. Claims 10 and 11 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, and Suh (US 8,507,787; issued Aug. 13, 2013).

Appellant's arguments focus on the subject matter of claim 1 (App. Br. 4-14). Accordingly, claims not separately argued will stand or fall with our analysis of the rejection of claim 1. Appellant does not contend that any of the applied references are unavailable as prior art to the claimed subject matter. *See*, Ans. 3-5.

FINDINGS OF FACT & ANALYSIS

Appellant argues that the Examiner's rejection lacks articulated, credible reasoning to support the obviousness rejection (App. Br. 4). Appellant contends that Farmer's teaching of a grading in composition to yield a grading in bandgap would not have suggested a window layer having a gradation in doping as required by claim 1 (App. Br. 5). Appellant argues that Grillot may teach that a layer can be graded in composition or dopant , but Grillot does not teach that composition graded layers are equivalent to dopant graded layers and would lead to the same properties as dopant graded layers (App. Br. 5-6). Appellant contends that Cornfeld's publication US 2013/0139877 A1 teaches that variations in composition in adjacent layers may result in graded band gap (App. Br. 6). Appellant argues that dopant graded layers can be used to provided increased current to a multi-junction solar cell as disclosed in ¶ 19 of the Specification. *Id.* Appellant contends that the Examiner's rationale for using Grillot's teaching that the semiconductor layers may be composition or dopant graded fails to identify a problem that using a dopant gradation or compositional gradation would address or if such a change would have a reasonable expectation of success (App. Br. 7-8).

Contrary to Appellant's arguments, the Examiner's rejection is based upon Newman teaching all the limitations in claim 1, except for a window layer having a dopant gradation as recited in claim 1 (Ans. 5-6). The Examiner finds that Farmer teaches a solar cell having a window layer that is compositionally graded so that the bandgap varies from the region in the window layer adjacent to the layer overlying the window layer so as to encourage minority carriers that are generated in the window layer to migrate to the emitter and it can also help reduce drops in electrical potential

across the window layer (Ans. 6). The Examiner concludes that it would have been obvious to grade the composition of Newman's window layer as taught by Farmer in order to achieve the goals taught by Farmer (i.e., encouraging directional movement of minority carriers) (Ans. 6-7).

The Examiner finds that Newman as modified by Farmer teaches modifying the window layer by varying composition rather than doping (Ans. 7). The Examiner finds that Grillot teaches that a grading structure may be achieved by creating a change in composition and/or dopant concentration (Ans. 7). The Examiner concludes that it would have been obvious to Grillot's doping to form Newman's window layer having a graded composition as modified by Farmer because grading by doping is within the ordinary skill of the art and common sense (Ans 7). The Examiner finds that Grillot teaches that grading by doping leads to anticipated success (Ans. 7). We understand the Examiner to find that Grillot teaches that a layer may be successfully graded by providing a change in the composition of the layers by either doping or compositional variation. In other words, we understand the Examiner to find that doping is another way to produce a layer graded in composition (Ans. 24-25).

Although Appellant argues that dopant and compositionally graded layers may produce layers having different properties, Appellant cites only his own disclosure in the Specification and a pre-grant publication of the present inventor as evidence of this alleged difference in properties (App. Br. 6). Appellant's attorney argument and evidence of the inventor does not necessarily establish that compositional grading yields a different product cell than dopant grading. Indeed, the preponderance of the evidence favors

the Examiner that dopant grading or compositional grading will produce a graded difference in composition through the layer as taught by Grillot.

The difference in properties argued by Appellant on page 6 of the Appeal Brief seems to compare the compositional variation in a AlGaInAs material layer with a dopant graded window layer made of AlInP (Spec. ¶ 19, 30; App. Br. 6). In other words, Appellant's conclusions regarding comparison of a compositional graded layer with a dopant graded layer cannot be said to establish that the properties of the layers would necessarily be different in a dopant graded window layer as compared to Farmer's compositionally graded window layer. Rather, Appellant's argument is contradicted by Farmer that teaches a compositionally graded layer possesses the same property (*i.e.,* encourages minority carriers to migrate to the emitter) as claimed by Appellant with regard to a dopant graded layer.

Though Appellant argues that the Examiner has not established that a gradation in doping would yield a gradation in bandgap (Reply Br. 2), the variation in bandgap appears to be affected by the composition of the layer as taught by Farmer (¶ 159). Because dopant grading would affect the composition of the layer, there is a reasonable basis to find that bandgap would be affected by the change in composition. Appellant contends that the density of carriers in a compositionally graded layer is four orders of magnitudes greater than the density of carriers in a dopant graded layer (i.e., 10^{22} vs. 10^{18}) (Reply Br. 3). Appellant fail to cite any evidence to support the position that the density of carriers in a compositionally graded layer is "typically on the order of 5 x 10^{22} atoms cm^{-3}" as argued. *Id.* Appellant's mere arguments are insufficient to convince us of reversible error in the Examiner's rejection.

The Examiner is not relying on dopant and compositional graded layers as being equivalent as argued by Appellant. Rather, the Examiner's position is that dopant grading is another way to achieve compositional variation in a layer. Grillot's disclosure supports the Examiner's position. In light of the teachings of Grillot, Farmer, and Newman as a whole, we find that the Examiner reasonably concluded that it would have been obvious to form a dopant graded window layer to encourage minority carriers to migrate to the emitter as taught by Farmer with respect to a compositionally graded window layer. On this record, we affirm the Examiner's § 103(a) rejection over Newman, Farmer and Grillot.

Appellant's only arguments regarding rejections (2) to (4) and (6) is that the additional references do not cure the alleged deficiencies of Newman, Farmer and Grillot (App. Br. 9-12, 14). For the reasons discussed above, we affirm the Examiner's rejection (2) to (4) and (6).

Regarding rejection (5), Appellant argue it is improper to include Li as an evidentiary reference in a § 103 (a) rejection (App. Br. 12-13). Appellant contends that it is unclear if Li is part of the obviousness rejection or not (App. Br. 13).

The Examiner suggests combining Fafard's p-i-n cell in a compound semiconductor solar cell grown by metal organic vapor deposition as a known substitute for p/n stuctures as in Newman (Ans. 17). Fafard does not teach that the metal organic deposition process is unintentionally doped. The rejection is clear that Li is relied upon to teach that unintentional doping of layers deposited by metal organic chemical vapor deposition is typical

and well-known in semiconductor manufacturing (Ans. 17). The Examiner relies on Li to show that the intrinsic layer in a p-i-n cell of Newman as modified by Fafard would be unintentionally doped when formed by metal organic vapor deposition (Ans. 18).

As we understand the rejection, the Examiner used Li to properly support the finding that unintentional doping would have occurred in Fafard's metal organic chemical vapor deposited layer. We note that Appellant does not dispute the findings of the Examiner with regard to Li. Appellant's citation to § 2131 of the *Manual of Patent Examining Procedures* (MPEP) is directed to the use of more than one reference in a § 102 rejection (App. Br. 12). That section of the MPEP is not relevant to the 35 U.S.C. § 103 rejection present here. Appellant cites to § 2141.02(V) for the proposition that obviousness cannot be predicated on what is unknown is also not applicable here (App. Br. 13). The Examiner cites to Li to establish what was known in the art with regard to the unintentional doping of metal organic chemical vapor deposited layers. The Examiner is not basing the obviousness conclusion on what was unknown, but rather what was known to the ordinarily skilled artisan.

On this record, we affirm the Examiner's § 103(a) rejection over Newman, Farmer, Grillot, Farfard as evidenced by Li.

DECISION

The Examiner's decision is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

ORDER

AFFIRMED