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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte ARTHUR CORNFELD

Appeal 2015-001556
Application 13/768,683
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 1–19. We have jurisdiction over the appeal pursuant to 35 U.S.C. § 6(b).

We AFFIRM.

Appellant's invention is directed to multijunction solar cells based on III-V semiconductor compounds, and to fabrication processes and devices for five and six junction solar cell structures including a metamorphic layer (Spec. ¶ 40).

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

1. A multijunction solar cell comprising:

an upper first solar subcell having a first band gap, and a base region and an emitter region;

a window layer disposed over the upper first solar subcell, 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 layer overlying the window layer;

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;

a first graded interlayer adjacent to said second solar subcell, said first graded interlayer having a third band gap greater than said second band gap;

a third solar subcell adjacent to said first graded interlayer and having a fourth band gap smaller than said third band gap and being lattice mismatched with the second solar subcell;

a second graded interlayer adjacent to said third solar subcell, said second graded interlayer having a fifth band gap greater than said fourth band gap; and

a fourth solar subcell adjacent to said second graded interlayer, said fourth subcell having a sixth band gap smaller than said fifth band gap such that said fourth subcell is lattice mismatched with respect to said third subcell.

Appellant appeals the following rejections:

1. Claims 1, 3, and 13–17 are rejected under 35 U.S.C. § 103(a), as unpatentable over Newman et al. (US 2010/0229926 A1, published Sept. 16, 2010) ("Newman") in view of Farmer et al. (US 2010/0218819 A1, published Sept. 2, 2010) ("Farmer") and Grillot et al. (US 7,951,693 B2, issued May 31, 2011) ("Grillot").
2. Claims 2, 18, and 19 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) ("Nie").

3. Claims 4, 5, and 11 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) ("Misra").
4. Claim 6 is 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).
5. Claims 7 and 8 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, Fafard (US 7,863,516 B2, issued Jan. 4, 2011) and as evidenced by Li et al. (*Unintentional doping and compensation effects of carbon in metal-organic chemical-vapor deposition fabricated ZnO thin films*, 24 J. Vac. Sci. & Tech. 1213–1217(2006)) ("Li").
6. Claims 9 and 10 are rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, and Suh (US 8,507,787 B2, issued Aug. 13, 2013).
7. Claim 12 is rejected under 35 U.S.C. § 103(a) as unpatentable over Newman in view of Farmer, Grillot, and Karam et al. (US 6,150,603, issued Nov. 21, 2000) ("Karam").

Appellant's arguments focus on the subject matter of claim 1 (App. Br. 5–16). Accordingly, claims not separately argued will stand or fall with our analysis of the rejection of claim 1.

FINDINGS OF FACT & ANALYSIS

Appellant argues that the Examiner's rejection lacks articulated, credible reasoning to support the obviousness rejection (App. Br. 5).

Appellant contend 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. 6). 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. 6). Appellant contends that the disclosure in ¶ 132 of the Specification teaches that variations in composition in adjacent layers may result in a variation in lattice constant (App. Br. 7). Appellant argues that according to Stan's disclosure in ¶¶ 73 to 80 of US 2009/0155952 A1 dopant graded layers can be used to provide a constant or linear varying collection field that can be advantageous for both minority carrier collection and for radiation hardness at the end-of-life of the solar cell. *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. 8–9).

Contrary to Appellant's arguments, the Examiner's rejection is based upon Newman teaching all of the limitations in claim 1, except for a window layer having a dopant gradation as recited in claim 1 (Ans. 4–5). 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. 5). 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).

The Examiner finds that Newman as modified by Farmer teaches modifying the window layer by varying composition rather than doping (Ans. 6). The Examiner finds that Grillot teaches that a grading structure may be achieved by creating a change in composition and/or dopant concentration (Ans. 6). The Examiner concludes that it would have been obvious to use 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. 6). The Examiner finds that Grillot teaches that grading by doping leads to anticipated success. *Id.* 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).

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 that includes the present inventor as a co-inventor as evidence of this alleged difference in properties (App. Br. 7). Appellant's attorney argument and evidence of the inventor does not necessarily establish that compositional grading is different 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 compare the compositional variation in a AlGaInAs material layer with a dopant graded profile between an emitter and base layer (Spec. ¶ 132; App. Br. 7; Stan ¶ 73). In other words, Appellant's conclusions regarding the 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 argued and disclosed by Appellant with regard to a dopant graded layer. Moreover, Stan teaches that a dopant graded layer affects minority carrier collection (Stan ¶ 79). In other words, the prior art recognizes that dopant gradation in a layer may be used for the same purpose as Farmer (i.e., minority carrier collection near the emitter).

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 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 rejection (App. Br. 13–14). Appellant contends that it is unclear if Li is part of the obviousness rejection or not (App. Br. 14).

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 structures as in Newman (Ans. 15–16). 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. 15–16). 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. 16).

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. 13). 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 rejection over Newman, Farmer, Grillot, and Fafard 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