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Shumaker & Sieffert, P.A./U of M 1625 Radio Drive, Suite 100 Woodbury, MN 55125			MALLEY JR., DANIEL PATRICK	
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte TIANHONG CUI and SHOTA SANDO

Appeal 2019-001323
Application 14/840,694
Technology Center 1700

Before JEFFREY B. ROBERTSON, MONTE T. SQUIRE, and BRIAN D. RANGE, *Administrative Patent Judges*.

RANGE, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner's decision to reject claims 1–14. We have jurisdiction under 35 U.S.C. § 6(b).

We REVERSE.

¹ We use the word “Appellant” to refer to “applicant” as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as the Regents of the University of Minnesota. Appeal Br. 3.

CLAIMED SUBJECT MATTER²

The Specification explains that formaldehyde is a toxic and carcinogenic chemical often used to make particle board and coatings. Spec. ¶ 1. Appellant describes the invention as relating to an “economical yet robust and highly sensitive formaldehyde sensor capable of providing a quick response.” Spec. ¶ 3. Claim 1 is illustrative:

1. A formaldehyde sensitive assembly suitable for use in the manufacture of a formaldehyde electrochemical sensor, comprising formaldehyde dehydrogenase attached to a single layer sheet of graphene.

REFERENCES

The Examiner relies upon the prior art below in rejecting the claims on appeal:

Shimomura et al. (“Shimomura”)	US 2009/0008248 A1	Jan. 8, 2009
Hughes et al. (“Hughes”)	US 2013/0053665 A1	Feb. 28, 2013

Schedin, F., Geim, A., Morozov, S., Hill, E., Blake, P., Katsnelson, M. and Novoselov, K. Detection of individual gas molecules adsorbed on graphene. *Nature Materials*, 6, pp.652-655 (2007) (“Schedin”).

Marzuki, N., Bakar, F., Salleh, A., Heng, L., Yusof, N., and Siddiquee, S. Development of electrochemical biosensor for formaldehyde determination based on immobilized enzyme. *Int’l J. of Electrochemical Sci.*, 7, pp. 6070–6083, (2012) (“Marzuki”).

² In this Decision, we refer to the Final Office Action dated Dec. 20, 2017 (“Final Act.”), the Appeal Brief filed July 3, 2018 (“Appeal Br.”), the Examiner’s Answer dated Sept. 27, 2018 (“Ans.”), and the Reply Brief filed Nov. 27, 2018 (“Reply Br.”).

Majidi, R. & Karami, A. Adsorption of formaldehyde on graphene and graphyne. *Physica E: Low-dimensional Systems and Nanostructures*, 59, pp. 169–173, (2014) (“Majidi”).

REJECTIONS

The Examiner maintains the following rejections on appeal:

- A. Claims 1, 2, and 4–9 under 35 U.S.C. § 103 as obvious over Shimomura in view of Majidi. Ans. 4.
- B. Claims 3, 10, and 14 under 35 U.S.C. § 103 as obvious over Shimomura in view of Majidi and Hughes. *Id.* at 8, 12.
- C. Claims 11 and 12 under 35 U.S.C. § 103 as obvious over Shimomura in view of Majidi and Marzuki. *Id.* at 10.
- D. Claim 13 under 35 U.S.C. § 103 as obvious over Shimomura in view of Majidi and Schedin. *Id.* at 13–14.
- E. Claim 13 under 35 U.S.C. § 112 as indefinite. *Id.* at 3.³

OPINION

Rejections A-D: Obviousness over Shimomura and Majidi. The Examiner has the initial burden of establishing a prima facie case of obviousness under 35 U.S.C. § 103. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992) (“[T]he examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a *prima facie* case of unpatentability.”). To establish a prima facie case of obviousness, the

³ Although the Examiner addresses this Section 112 rejection first in the Final Office Action (Final Act. 2), we address this rejection last so that our ordering of the rejections is consistent with Appellant’s numbering. *See* Appeal Br. 17 (referring to the Section 112 rejection as the “FIFTH GROUND OF REJECTION”).

Examiner must show that each and every limitation of the claim is disclosed or suggested by the prior art or would have been obvious based on the knowledge of those of ordinary skill in the art or the inferences and creative steps a person of ordinary skill in the art would have employed. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988); *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).

To resolve the issues before us on appeal, we focus on the Examiner's findings and determinations that relate to the error Appellant identifies. The Examiner rejects independent claims 1 and 4 as obvious over Shimomura in view of Majidi. Ans. 4. These claims recite formaldehyde dehydrogenase ("FALDH") either "attached to a single layer sheet of graphene" (claim 1) or at least partially coated on "a single sheet of graphene" (claim 4). The Examiner finds that Shimomura teaches layers of carbon nanotubes partially coated with an immobilized enzyme such as FALDH. Ans. 4. The Examiner finds, however, that Shimomura does not teach FALDH attached to a single layer sheet of graphene. *Id.* at 5. The Examiner finds that Majidi teaches adsorption of formaldehyde on graphene and teaches application of this property in high sensitivity sensors. *Id.* The Examiner determines that "it would have been obvious to replace the carbon nanomaterial as taught by Shimomura . . . with the carbon nanomaterial as disclosed by Majidi . . . as Majidi et al. teaches that there is a potential application for a high sensitivity formaldehyde sensor." *Id.*; *see also, e.g., id.* at 21.

Appellant argues that the Examiner has not established that one of ordinary skill in the art would have had a reason to modify the applied references to arrive at the claimed subject matter. Appeal Br. 6. In particular, Appellant emphasizes that Shimomura teaches that its enzyme

(e.g., FALDH) is immobilized in the carbon nanotube layer. *Id.* at 8–9 (citing Shimomura, Abstract, ¶ 89). Appellant also explains that Majidi teaches a detection mechanism different from Shimomura—namely, Majidi teaches adsorption of formaldehyde on graphene without the use of an enzyme such as FALDH. Appeal Br. 6–7. Appellant, thus, argues that replacing Shimomura’s nanotubes with the graphene of Majidi would change Shimomura’s principle of operation because the two references use different methods of measuring formaldehyde. *Id.* at 9–10.

The preponderance of the evidence supports Appellant’s position. In particular, Appellant correctly explains that Shimomura discourages placement of enzymes on an outer layer such that the enzymes are applied to a flat surface or are not immobilized. Appeal Br. 9. Shimomura teaches that carbon nanotubes enable “higher concentration by a larger amount of absorption in comparison” compared to use of a flat surface. Shimomura ¶ 11. Shimomura also teaches that it is desirable to include an immobilization layer “to function as an outflow preventing section to prevent the outflows of the enzymes 4 immobilized in the carbon nanotube layer L.” *Id.* ¶ 92. Shimomura explains that it uses carbon nanotubes as electrodes that serve to regenerate the immobilized enzymes. *Id.* at Fig. 5; Reply Br. 6.

Because of Shimomura’s emphasis on the use of carbon nanotubes and Majidi discloses direct adsorption of formaldehyde on graphene without the use of enzyme (Majidi, Abstract), we do not agree with the Examiner that a person of skill in the art would have had sufficient reason to substitute the carbon nanotubes with the single sheet of graphene taught by Majidi. Accordingly, we do not sustain the Examiner’s rejection of independent

claims 1 and 4. Because the Examiner's treatment of the dependent claims do not cure the error addressed above, we also do not sustain the Examiner's rejection of those claims.

Rejection 5: Indefiniteness of Claim 13. The Examiner rejects claim 13 under 35 U.S.C. § 112 as indefinite. Ans. 3. During prosecution, “[a] claim is indefinite when it contains words or phrases whose meaning is unclear.” *Ex parte McAward*, Appeal No. 2015-006416, slip op. at 11 (quoting *In re Packard*, 751 F.3d 1307, 1314 (Fed. Cir. 2014) (per curiam)).

Here, claim 13 depends from claim 4 and recites that “the graphene layer is layer-by-layer self-assembled on a wafer.” Appeal Br. 21 (Claims App.). The Examiner determines that the claim is unclear in view of claim 4's recitations (Ans. 3); namely, claim 4 requires the formaldehyde interactive material comprise “a single layer sheet of graphene at least partially coated with immobilized formaldehyde dehydrogenase.” Ans. 3. The Examiner states, “Applicant has already limited the graphene to be a single layer sheet of graphene [as in claim 4], it is therefore unclear how there can be multiple layers [as suggested by “layer-by-layer” assembly in claim 13].” *Id.* at 19.

Appellant argues that claim 13 is not unclear because “layer-by-layer” refers to an electrostatic self-assembly step that a person having ordinary skill in the art would recognize. Appeal Br. 18.

Based on the present record, the Examiner has not adequately explained why claim 13 is unclear. Appellant's Specification indicates that a “layer-by-layer” process could be used to assemble a device comprising a single sheet of graphene. *See Spec.* ¶¶ 24, 34. The Examiner has not

adequately explained why the “single sheet of graphene” and “layer-by-layer” recitations are inconsistent. We, thus, do not sustain this rejection.

CONCLUSION

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1, 2, 4–9	103	Shimomura, Majidi		1, 2, 4–9
3, 10, 14	103	Shimomura, Majidi, Hughes		3, 10, 14
11, 12	103	Shimomura, Majidi, Marzuki		11, 12
13	103	Shimomura, Majidi, Schedin		13
13	112	Definiteness		13
Overall Outcome				1–14

REVERSED