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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 ROBERT W. CUMBERLAND

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Appeal 2019-000309
Application 14/198,801
Technology Center 1700

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Before MICHAEL P. COLAIANNI, GEORGE C. BEST, and DEBRA L. DENNETT, *Administrative Patent Judges*.

COLAIANNI, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant[1] appeals under 35 U.S.C. § 134 the final rejections of claims 16–21, 23–30, and 32. Claims 1–15, 22, and 31 have been canceled. We have jurisdiction over the appeal pursuant to 35 U.S.C. § 6(b).

We REVERSE.

The invention is directed to an array of substantially aligned boron nitride nano-elements and a microelectronic device which includes such an array (claims 16 and 23; Spec. ¶¶ 6, 7).

[1] According to the Appeal Brief, the real party in interest is listed as "The Boeing Company" (App. Br. 1).

Claims 16 and 23 are illustrative:

16. An array of substantially aligned boron nitride nano-elements, the array comprising:

a plurality of substantially aligned carbon nano-elements; and

a plurality of boron nitride nano-elements formed on, and extending from, ends of said plurality of substantially aligned carbon nano-elements, the boron nitride formed from a source of boron atoms and a source of nitrogen atoms, wherein the source of boron atoms comprises a boron containing compound selected from a group consisting of BH_3, B_2H_4, and B_2H_6.

23. An electronic device comprising:

at least one of a heat-generating component and a heat sink; and

an array of substantially aligned boron nitride nano-elements deposited on a surface of the at least one of a heat-generating component and a heat sink, the array comprising:

a plurality of substantially aligned carbon nano-elements; and

a plurality of boron nitride nano-elements formed on, and extending from, ends of said plurality of substantially aligned carbon nano-elements, the boron nitride formed from a source of boron atoms and a source of nitrogen atoms, wherein the source of boron atoms comprises a boron containing compound selected from a group consisting of BH_3, B_2H_4, and B_2H_6.

Appellant appeals the following rejections:

1. Claims 16–21, 23, 26–30, and 32 are rejected under 35 U.S.C. § 103(a) as unpatentable over Arik et al. (US 2005/0006754 A1, published Jan. 13, 2005, "Arik") in view of Bando et al. (JP 2004-190183, published July 8, 2004, and relying on a machine translation, "Bando"), and Unger et al. (US 2005/0040847 A1, published Feb. 24, 2005, "Unger").

2. Claims 24 and 25 are rejected under 35 U.S.C. § 103(a) as unpatentable over Arik in view of Bando, Unger, and Gross et al. (US 2010/0190023 A1, published July 29, 2010, "Gross").
3. Claims 19, 20, 28, and 29 are rejected under 35 U.S.C. § 103(a) as unpatentable over Arik in view of Bando, Unger, and Leu et al. (US 2005/0092464 A1, published May 5, 2005, "Leu").

Appellant's arguments focus only on the subject matter of claims 16 and 23 (App. Br. 2–3, 8–10). Accordingly, any claim not argued separately will stand or fall with our analysis of claims 16 and 23 under rejection (1).

FINDINGS OF FACT & ANALYSIS

REJECTION (1)

The Examiner rejects claims 16 and 23 over the combined teachings of Arik in view of Bando and Unger (Final Act. 2–5).

The Examiner finds Arik teaches that boron nitride nano-elements, which possess both high thermal and low electrical conductivity, are beneficial for connecting a heat source to a heat sink in an electrical device (*id.* at 2). The Examiner finds that Bando teaches a method of coating boron-nitride onto an array of carbon nanotubes (*id.* at 3). The Examiner concludes that it would have been obvious at the time of the invention to apply Bando's use of boron and nitrogen gases to form Arik's boron-nitride nanotubes (*id.*).

Appellant does not contest the combination of Arik and Bando (App. Br. 3–5). The Examiner finds that Arik and Bando fail to teach that boron nitride nano-elements are formed on, and extend from, the ends of carbon nano-elements (Final Act. 5).

The Examiner, however, finds that Unger teaches forming an electrical device by providing a plurality of first nano-elements; then providing growth catalysts thereon; and thereafter, growing a plurality of second nano-elements from the end of the first nano-elements (*id.*). The Examiner concludes that it would have been obvious to use Unger's method to form the second nano-elements from boron nitride, starting from the first carbon nano-elements' ends, in order to provide useful connective nano-structures in electrical and/or thermal control devices, as taught by Arik in view of Bando (*id.*). The Examiner determines that such a modification would have been obvious because Arik teaches that boron nitride nanotubes are desirable for connecting electrical elements that are thermally conductive and electrically insulating (*id.*).

Appellant argues that although Unger teaches forming nano-elements from pre-existing nano-elements, Unger fails to teach "forming the second nano[-]element[s] from a different material than the first nano[-]element[s]" (App. Br. 5).

We are not persuaded by this argument because Unger teaches or suggests that the second nano-elements may be formed from a different material than the first nano-element (*see* Unger ¶ 39 (disclosing that "[t]he first and/*or* the at least one second nanoelement may include a nanotube . . . [t]he nanotube may, for example, be a carbon nanotube, a carbon-boron nanotube, a carbon-nitrogen nanotube, a tungsten sulphide nanotube *or* a chalcogenide nanotube") (emphasis added)).

Appellant argues, *inter alia*, that Arik's electrical device is intended to provide electrically insulative regions of high thermal conductivity (App. Br. 6 (citing Arik ¶ 42)). Appellant contrasts this purpose of Arik's device with

Unger's intended purpose, namely to increase an array's electrical conductivity using branched carbon nanotubes (App. Br. 6 (citing Unger ¶¶ 3–5)). Appellant argues that the Examiner applies Arik to provide motivation for one of ordinary skill in the art to modify Unger's nanotube arrangement, which possesses increased electrical conductivity, instead to have electrically insulating properties (App. Br. 8). Appellant thus argues that the Examiner's proposed modification would render the resulting array unsuitable for the intended purpose of both Arik's and Unger's arrays (*id.* at 5–6).

In response, the Examiner asserts that "there is no evidence" that the resulting array would be unsuitable for its intended purpose (Ans. 10). The Examiner contends that Arik "is clearly still able to provide thermal connection using the nanotube growth process of" Unger, which "provid[es] two nano-elements" (*id.*).

The preponderance of the evidence favors Appellant's argument of non-obviousness. The Examiner has not adequately responded to Appellant's proffered evidence, which shows that Unger's purpose is to increase an array's electrical conductivity (Unger ¶¶ 3–5), whereas Arik's purpose is to provide electrically insulative regions (Arik ¶ 42). Unger teaches that the second nano-elements branch from a single first nano-element, thereby conferring the array's increased electrical conductivity (*id.* ¶¶ 5, 42, 43, 63; Fig. 2C).[2] On the other hand, Arik explicitly teaches that boron nitride nanotubes possess "low electrical conductivity" (Arik ¶ 42). In

[2] We note that Unger does not disclose boron nitride as a suitable material for the branched portion of the second nano-elements (Unger ¶ 39; claim 39).

other words, combining Unger's teaching to form branched second nano-elements having carbon nanotubes with good electrical conductivity at the end of Arik's boron nitride nanotubes having low electrical conductivity would have rendered Arik's device unsuitable for its intended purpose (i.e., good thermal conductivity, but low electrical conductivity). *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984).

We, therefore, are persuaded by Appellant that one of ordinary skill in the art would not have found it obvious to combine Unger's second nano-element from boron nitride into Arik's modified electrical device.

On this record, we reverse the Examiner's § 103(a) rejection (1) above.

REJECTIONS (2) and (3)

On this record, we reverse the Examiner's § 103(a) rejections (2) and (3).

DECISION

The Examiner's decision is reversed.

ORDER

REVERSED