UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte STEPHEN R. GILBERT, SANJEEV AGGARWAL,
SCOTT SUMMERFELT, and STEVAN G. HUNTER, SR.

Appeal 2007-0378
Application 10/212,895
Technology Center 2800

Decided: March 19, 2007

Before JAMES D. THOMAS, ALLEN R. MACDONALD, and JEAN R. HOMERE, *Administrative Patent Judges*.

MACDONALD, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134 from the Examiner's rejection of claims 1-20, the only claims pending in this application. We have jurisdiction under 35 U.S.C. § 6(b).

STATEMENT OF THE CASE

Appellants invented a method for forming a paraelectric capacitor. Specifically, a seed layer is deposited on an oxide electrode using a paraelectric material precursor. Then, a paraelectric layer is deposited on the seed layer using the paraelectric material precursor. This technique allows for, among other things, better grain size control and lower temperature processing (Specification 3:10-19). Claim 1 is illustrative:

> 1. A method for forming a paraelectric capacitor:
> forming a buried contact in a dielectric layer;
> forming an oxide electrode in contact with the buried contact;
> depositing a seed layer on the oxide electrode using a paraelectric material precursor;
> depositing a paraelectric layer on the seed layer using the paraelectric material precursor; and
> forming an upper electrode in contact with the paraelectric layer.

The Examiner relies on the following prior art references to show unpatentability:

Roeder	US 5,876,503	Mar. 2, 1999
Kim	US 6,229,166 B1	May 8, 2001
Norga	US 2003/0133250 A1	Jul. 17, 2003 (filed Jan. 21, 2003)[1]

The Examiner's rejections are as follows:

1. Claims 1, 7, 10, 11, 17, and 20 are rejected under 35 U.S.C. § 103(a) as unpatentable over Norga in view of Roeder.
2. Claims 2-6, 8, 9, 12-16, 18, and 19 are rejected under 35 U.S.C.

[1] Continuation of Application No. 09/857,320 filed Aug. 31, 2001, now U.S. Pat. 6,545,856.

§ 103(a) as unpatentable over Norga in view of Roeder and further in view of Kim.

Rather than repeat the arguments of Appellants or the Examiner, we refer to the Briefs and the Answer for their respective details. In this decision, we have considered only those arguments actually made by Appellants. Arguments which Appellants could have made but chose not to make in the Briefs have not been considered and are deemed to be waived. *See* 37 C.F.R. § 41.37(c)(1)(vii) (2004).

OPINION

We first consider the Examiner's rejection of claims 1, 7, 10, 11, 17, and 20 under 35 U.S.C. § 103(a) as unpatentable over Norga in view of Roeder. In rejecting claims under 35 U.S.C. § 103, it is incumbent upon the Examiner to establish a factual basis to support the legal conclusion of obviousness. *See In re Fine*, 837 F.2d 1071, 1073, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). In so doing, the Examiner must make the factual determinations set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966). If that burden is met, the burden then shifts to the Appellants to overcome the prima facie case with argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole and the relative persuasiveness of the arguments. *See In re Oetiker*, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992).

Regarding independent claims 1 and 11, the Examiner's rejection essentially finds that Norga teaches a capacitor forming method with every claimed feature except for depositing seed and paraelectric layers using the claimed precursor. The Examiner cites Roeder as teaching this feature and

concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to deposit the seed layer in Norga in the manner suggested by Roeder to grow a bulk paraelectric layer of crystalline structure for a capacitor (Answer 3-4).

Appellants argue that Norga does not teach nor suggest using the same paraelectric material precursor for the seed and paraelectric layers as claimed. Appellants contend that Norga teaches away from the claimed invention since a seed layer of high-Ti PZT[2] is deposited before the PZT layer to prevent reactions with the bottom electrode; therefore, the same precursor cannot be used (Br. 11). Regarding claims 7, 10, 17, and 20, Appellants add that the prior art teaches away from the claimed invention, particularly noting that Roeder deposits different precursor compositions (Br. 12).

The Examiner notes that Norga's PZT layer 35 comprises two sub-layers: (1) a first PZT sub-layer with a higher Ti concentration that corresponds to the claimed seed layer, and (2) a second PZT sub-layer that corresponds to the claimed paraelectric layer (Answer 7, 13). Appellants respond that these two sub-layers do not constitute a seed layer and a paraelectric layer as claimed, particularly in view of Norga's teaching of depositing a seed layer in ¶ 0063 (Reply Br. 3).

We will sustain the Examiner's rejection of independent claims 1 and 11. At the outset, we note that although claim 1 requires using the same paraelectric precursor for both the seed layer and the overlying paraelectric layer as Appellants argue, the claim nonetheless does not preclude using

[2] PZT is an acronym for a lead zirconate titanate composition. *See* Roeder, col. 3, l. 26.

additional precursors. That is, the limitation is fully met by forming the seed layer and overlying paraelectric layer using a common precursor, notwithstanding the use of additional precursors.

With this interpretation in mind, we turn to the prior art. As the Examiner indicates, Norga's PZT layer 35 comprises two sub-layers: (1) a first PZT sub-layer adjacent to the bottom electrode 34, and (2) a second PZT sub-layer on the first sub-layer. The first sub-layer has Ti concentration higher than the second sub-layer (Norga, ¶ 0062).

We disagree with Appellants that the first sub-layer is not a seed layer as claimed. First, we see no reason why the first sub-layer in Norga cannot function as a seed layer, particularly since it is disposed adjacent to the bottom electrode 34 – an arrangement commensurate with the seed layer disclosed in the present application. *See* Fig. 2 of the present application (showing seed layer 45 adjacent to electrode 44). Moreover, Appellants have provided no evidence on this record establishing that the first sub-layer is incapable of functioning as a seed layer.

Second, even if we assume, without deciding, that Norga provides a seed layer in addition to the two sub-layers of PZT layer 35 as Appellants seem to suggest, such an additional seed layer is not required. Rather, an additional seed layer is merely recommended for certain PZT layers with Zr/Zr+Ti concentrations greater than 0.2 to improve crystallinity of the formed layers (Norga, ¶ 0063). In our view, the first sub-layer in Norga reasonably constitutes a seed layer as claimed giving the term its broadest reasonable interpretation.

Although Norga is silent regarding the specific precursors used to form these respective PZT sub-layers, Roeder teaches depositing PZT layers utilizing multiple vaporizers (vaporizers 18 and 20) that vaporize certain liquid precursors that are directed to the corresponding vaporizer (Roeder, col. 9, ll. 14-34; col. 9, l. 58 – col. 10, l. 49; Fig. 1).

In one embodiment, a seed layer 212 of $PbTiO_3$ is first deposited using only the vaporizer 18. That is, only the precursor vaporized by vaporizer 18 is used. Next, a $PbZrTiO_3$ layer 214 is formed on the seed layer using both vaporizers 18 and 20 (i.e., the second vaporizer's "run valve" is opened to admit Zr precursor to the CVD reactor) (Roeder, col. 11, ll. 24-47; Fig. 3).[3] That is, the layer 214 is formed using both precursors (i.e., precursors vaporized by both vaporizers 18 and 20). Since both layers 212 and 214 are formed using a common precursor (i.e., the precursor vaporized by vaporizer 18), the layers are therefore formed using the same precursor as claimed, notwithstanding the use of an additional Zr precursor for layer 214. Moreover, we find this teaching reasonably combinable with Norga's deposition process of PZT layers in a capacitor. Such a system would not only facilitate precisely applying the same precursor to multiple layers as noted above, but would also facilitate precisely controlling the application of multiple, incompatible precursors with separate vaporizers. *See, e.g.*, Roeder, col. 6, ll. 40-63.

[3] Significantly, these same compositions are cited in the present application as exemplary seed and ferroelectric layers. *See* Specification 5:5-10 (noting that the composite ferroelectric layers 36, 46 are reactive seed layers including, among other things, $PbTiO_3$ disposed under PZT ($PbZr_xTi_{(1-x)}O_3$).

For at least these reasons, we will sustain the Examiner's rejection of independent claims 1 and 11 and dependent claims 7, 10, 17, and 20.

We next consider the Examiner's rejection of claims 2-6, 8, 9, 12-16, 18, and 19 under 35 U.S.C. § 103(a) as unpatentable over Norga in view of Roeder and further in view of Kim. The Examiner finds that the collective teachings of Norga and Roeder disclose every claimed feature except for (1) forming an oxide electrode; (2) depositing the paraelectric layer using nitrous oxide (N_2O) in the CVD process; (3) depositing the seed layer by using oxidizer gas to provide an oxidized seed layer; and (4) the claimed pressure, temperature, surface roughness, and thickness ranges. The Examiner cites Kim as teaching these features and concludes that it would have been obvious to the skilled artisan at the time of the invention to form the electrode, seed layer, and paraelectric layers in the manner claimed. The Examiner adds that the specific ranges of pressure, temperature, surface roughness, and thickness claimed in claims 3-5, 8, 9, 12-15, 18, and 19 involve routine optimization within the level of ordinary skill in the art (Answer 5-6).

Appellants first argue that the Examiner has provided no motivation for combining Roeder with Norga (Br. 13; Reply Br. 7). However, we find ample motivation on this record for the skilled artisan to combine the references. It is well settled that a teaching, suggestion, or motivation to combine the relevant prior art teachings does not have to be found explicitly in the prior art, but rather may be implicit from the prior art as a whole. The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as

a whole would have suggested to those of ordinary skill in the art. *In re Kahn*, 441 F.3d 977, 987-88, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006).

As we noted previously, combining the teachings of Roeder with Norga would not only facilitate precisely applying the same precursor to multiple layers, but also facilitate precisely controlling the application of multiple, incompatible precursors by using separate vaporizers. *See, e.g.*, Roeder, col. 6, ll. 40-63. In our view, such an advantage would have been readily apparent to the skilled artisan given the combined teachings of the prior art and the general knowledge of those skilled in the art.

Appellants also argue that the prior art teaches away from using the same paraelectric material precursor for the seed and PZT layers (Br. 13). But as we previously indicated, the limitation is fully met by forming the seed layer and overlying paraelectric layer with a common precursor as taught in the prior art, notwithstanding the use of additional precursors.[4]

Regarding claim 16, Appellants argue that since Norga requires a nano-crystalline conductive oxide electrode, Kim's method of forming an oxide electrode without a nano-crystalline electrode would render Norga inoperative (Br. 14; Reply Br. 8). The Examiner argues that the combination is proper since Norga and Kim teach using the same material for the conductive oxide electrode (Answer 11).

We agree with the Examiner. On this record, we see no reason why Kim's PZT deposition method that uses an oxidizing gas with nitrous oxide would not be compatible with the electrode of Norga, particularly since they are the same material. Appellants have simply offered no evidence on this

[4] *See* Pages 5-6, *supra*, of this opinion.

record to rebut this position. The Examiner's rejection of claim 16 is therefore sustained.

Regarding claims 3-5 and 12-14, Appellants argue that the claimed pressure and temperature ranges are critical to achieve the unexpected result of forming an upper electrode in contact with the paraelectric layer (Br. 15). The Examiner argues that (1) the pressure and temperature ranges in Kim are within the claimed ranges, and (2) the claimed ranges involve routine optimization within the level of ordinary skill in the art (Answer 12).

We will sustain the Examiner's rejection of claims 3-5 and 12-14. As the Examiner indicates, Kim teaches depositing the PZT layer via CVD methods with a chamber pressure of 0.1-10 Torr – a range that completely encompasses the claimed pressure range (Kim, col. 7, ll. 30-37). Moreover, Kim discloses a deposition temperature of 450-800°C – a temperature range that overlaps the claimed temperature range (*Id.*).

A prima facie case of obviousness arises when claimed ranges overlap the ranges disclosed in the prior art. *In re Harris*, 409 F.3d 1339, 1341, 74 USPQ2d 1951, 1953 (Fed. Cir. 2005). "Where the claimed ranges are completely encompassed by the prior art, the conclusion that the claims are prima facie obvious is even more compelling than in cases of mere overlap. Even without complete overlap of the claimed range and the prior art range, a minor difference shows a prima facie case of obviousness." *Id.* (internal quotation marks and citations omitted); *see also* MPEP § 2144.05.

Although Appellants contend that both the pressure and temperature ranges are critical to achieve the unexpected result of forming an upper electrode in contact with the paraelectric layer, Appellants have simply not rebutted the Examiner's prima facie case of obviousness on this record.

Regarding the claimed pressure range, Appellants have provided no concrete evidence establishing that the prior art pressure or temperature ranges would be incapable of achieving the unexpected result – forming an upper electrode in contact with the paraelectric layer. Regarding the temperature range, although Appellants point out the criticality of a processing temperature below 600°C – the claimed range nevertheless overlaps the prior art range between 450°C and 600°C .

In short, Appellants have simply not rebutted the Examiner's prima facie case of obviousness for the temperature and pressure ranges claimed in claims 3-5 and 12-14. Nor have Appellants rebutted the Examiner's prima facie case of obviousness with respect to the surface roughness and thickness ranges claimed in claims 8, 9, 18, and 19. Accordingly, the Examiner's rejection of claims 3-5, 8, 9, 12-14, 18, and 19 is sustained. Moreover, since Appellants have not separately argued the patentability of dependent claims 2, 6, 8, 9, 15, 16, 18, and 19 with particularity, these claims fall with independent claims 1 and 11. *See In re Nielson*, 816 F.2d 1567, 1572, 2 USPQ2d 1525, 1528 (Fed. Cir. 1987); *see also* 37 C.F.R. § 41.37(c)(1)(vii).

DECISION

We have sustained the Examiner's rejections with respect to all claims on appeal. Therefore, the Examiner's decision rejecting claims 1-20 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)(1)(iv) (2004).

AFFIRMED

PGC

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