Paper No. 51

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte MASAMICHI AZUMA, MICHAEL C. SCOTT,
CARLOS A. PAR DE ARAUJO and JOSEPH D. CUCHIARO

Appeal No. 1999-2712
Application No. 08/165,082

HEARD: October 24, 2000

Before HAIRSTON, JERRY SMITH, and LEVY, ***Administrative Patent Judges.***

LEVY, ***Administrative Patent Judge***.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the examiner's final rejection of claims 1-13, which are all of the claims pending in this application.

BACKGROUND

The appellants' invention relates to an integrated circuit (IC) including a capacitor having a layer of barium strontium titanate (BST) interposed between the electrodes. Specifically, the layer of BST has a thickness of less than 1000 nanometers and an average grain size smaller than 200 nanometers. An understanding of the invention can be derived from a reading of exemplary claim 1, which is reproduced as follows:

> 1. An integrated circuit including a capacitor comprising a pair of electrodes and a layer of barium strontium titanate interposed between said pair of electrodes, said layer of barium strontium titanate having a thickness of less than 1000 nanometers and having an average grain size smaller than 200 nanometers.

The prior art references of record relied upon by the examiner in rejecting the appealed claims are:

Brandmayr et al. (Brandmayr)	3,862,829	Jan. 28, 1975
Wilson et al[1]. (Wilson)	4,699,084	Oct. 13, 1987
Miller et al. (Miller)	5,046,043	Sep. 03, 1991

Koyama et al., A Stacked Capacitor With $(Ba_xSr_{1-x})TiO_3$ For 256M DRAM, pp.823-826, (IEDM, Dec. 1991). (Koyama)

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[1] The examiner has cited the reference to Wilson for the first time in the examiner's answer, but has not specifically applied the reference against any of the claims. As appellants have presented arguments with respect to the Wilson reference in the reply brief, we will consider the reference in order to completely consider on the record the examiner's basis for rejecting the claims.

McMillan et al., Deposition Of $Ba_{1-x}Sr_xTiO_3$ And $SrTiO_3$ via Liquid source CVD (LSCVD) For ULSI DRAMS, (ISIF Conf., Mar. 9-11, 1992). (McMillan)

Claims 1, 2 and 13 stand rejected under 35 U.S.C. § 103 as being unpatentable over Koyama in view of Brandmayr.

Claim 3 stands rejected under 35 U.S.C. § 103 as being unpatentable over Koyama in view of Brandmayr and further in view of McMillan.

Claims 4-12 stand rejected under 35 U.S.C. § 103 as being unpatentable over Koyama in view of Brandmayr, and further in view of Miller.

Rather than reiterate the conflicting viewpoints advanced by the examiner and the appellants regarding the above-noted rejections, we make reference to the examiner's answer (Paper No. 42, mailed June 10, 1998) for the examiner's complete reasoning in support of the rejections, and to the appellants' brief (Paper No. 41, filed February 13, 1998) and reply brief (Paper No. 43, filed July 30, 1998) for the appellants' arguments thereagainst.

OPINION

In reaching our decision in this appeal, we have carefully considered the subject matter on appeal, the rejections advanced by the examiner and the evidence of obviousness relied upon by the examiner as support for the rejections. We have, likewise, reviewed and taken into consideration, in reaching our decision, the appellants' arguments set forth in the briefs along with the examiner's rationale in support of the rejections and arguments in rebuttal set forth in the examiner's answer.

It is our view, after consideration of the record before us, that the evidence relied upon and the level of skill in the particular art would not have suggested to one of ordinary skill in the art the obviousness of the invention as set forth in claims 1-13. Accordingly, we reverse.

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 is expected to make the factual determinations set forth in ***Graham v. John Deere Co.***, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966), and to provide a reason why one having ordinary skill in the pertinent art would have been led to modify the prior art or to combine prior art references to arrive at the claimed invention. Such reason must stem from some teaching, suggestion or implication in the prior art as a whole or knowledge generally available to one having ordinary skill in the art. ***Uniroyal, Inc. v. Rudkin-Wiley Corp.***, 837 F.2d 1044, 1051, 5 USPQ2d 1434, 1438 (Fed. Cir.), ***cert. denied***, 488 U.S. 825 (1988); ***Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.***, 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985), ***cert. denied***, 475 U.S. 1017 (1986); ***ACS Hosp. Sys., Inc. v. Montefiore Hosp.***, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). These showings by the examiner are an essential part of complying with the burden of presenting a ***prima facie*** case of obviousness. ***Note In re Oetiker***, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992). If that burden is met, the burden then shifts to the applicant to overcome the ***prima facie*** case with argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole.

See id.; ***In re Hedges***, 783 F.2d 1038, 1039, 228 USPQ 685, 686 (Fed. Cir. 1986); ***In re Piasecki***, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); and ***In re Rinehart***, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976).

We consider first the rejection of claim 1, the only independent claim in the application, based on the teachings of Koyama and Brandmayr. The examiner asserts (answer, page 3) that Koyama teaches a stacked capacitor intended for use in an integrated circuit wherein a layer of BST is interposed between a pair of electrodes. Koyama discloses the thickness of the BST layer to be 70 nm - 200 nm. The examiner notes that ***id.***, "No micrograph of barium strontium titanate is shown, however, nor is there any explicit discussion of the grain size in the text of the article." To make up for this deficiency in Koyama, the examiner turns to Brandmayr for a teaching of a dielectric material formed of BST, and having a grain size less than 0.1 micron (100 nanometers). As stated by the examiner, Brandmayr teaches (col. 2, lines 1-24) the advantages of increased dielectric constant, increased dielectric strength and decreased porosity.

We note that appellants' specification (page 1) discloses that BST was known to be useful in making integrated circuit thin film capacitors having high dielectric constants, and refers to Koyama as an example of an integrated circuit thin film capacitor utilizing BST as a dielectric material. The specification goes on to state ***id.***, that "conventional processes, while useful in conventional silicon technology, when used in combination with capacitors that use metal oxides, such as BST, as the

dielectric, result in capacitors that have relatively high leakage current, fatigue significantly and generally have undesirable electrical properties." Appellants' solution (specification, page 2) is that "[t]he present invention solves the above problems by providing BST thin films in which the grain size is much smaller than the thickness of the film. . . . Thus the grain size in the BST thin films according to the invention is 2.5 to 5 times smaller than the surface film thickness. This small grain size results in capacitors with much improved electrical properties."

Appellants state (brief, page 8) that "the primary considerations that Appellants wish to place before the Board are whether the combined references teach the claimed invention, whether there is suggestion or motivation to combine the Brandmayr er al. '829 patent with the other references, . . . whether the Brandmayr et al '829 patent is nonanalogous art because it is in the field of bulk ceramics" and that (reply brief, pages 1 and 2) "if the Brandmayr reference is in fact considered by those skilled in the art, it would teach them away from the claimed invention because the process conditions that are used to make the Brandmayr materials are destructive to integrated circuit wiring layers."

Specifically, appellants assert (brief, page 9) that Brandmayr relates to bulk ceramic capacitors with high dielectric constants and that the combination of Koyama with Brandmayr teaches nothing more than a large bulk monolithic capacitor connected to an integrated circuit. According to appellants (brief, page 10) "[t]he problem with making this modification, apart from a lack of suggestion or motivation for those skilled in the art to perform the modification, is that the process conditions which

are reported in the Brandmayr et al. ‘829 reference cannot be used to form the claimed IC film because the process conditions are inherently destructive of IC components.”

The examiner’s position (answer, page 6) is that “no claims on appeal recite anything at all about how the device is to be made.” While the examiner is correct that the claims are drawn to a product and not a method of manufacture, the issue remains as to whether one of ordinary skill in the art would have been motivated to have provided Koyama with a grain size of less than 200 nanometers in view of the teachings of Brandmayr. From our review of Brandmayr, we are in agreement with appellants (brief, page 9) that Brandmayr is directed toward bulk ceramic capacitors. We find that Brandmayr is not directed to a capacitor in an integrated circuit.

The examiner asserts (answer, page 6) that “if one of ordinary skill in the art were to attempt to apply the Brandmayr *process* to the device structure as disclosed by Koyama et al., there would certainly be no reason why this could not been done” [italics original]. Appellants assert (brief, page 11) that “Example 3 of Brandmayr et al. ‘829, describes BST ceramic materials that have been subjected to 1100EC and 10,000 to 30,000 psi for one hour. These process conditions are unsuited for IC processes.” Appellants additionally note (reply brief, page 4) that the process of Brandmayr uses an inert atmosphere of He or Ar, whereas the integrated circuit anneal requires oxygen for oxidation of the metal-containing precursor residue on the substrate. Appellants have provided a

Declaration by Vikram Joshi[2] (Joshi Declaration), in support of their position that the process of Brandmayr could not be applied to an integrated circuit including a capacitor having a dielectric formed of BST. The examiner asserts (answer, page 7) that appellants attempt "to present some form of impossibility argument, based primarily on the Declaration submitted 8/29/97." The Joshi Declaration states that "[t]he device that was

tested . . . was prepared according to the general process described in the present application, except that it was annealed at high temperatures corresponding roughly to the anneal temperatures of the Brandmayr patent." According to the Joshi Declaration, the BST film had an average thickness of 1450D (i.e, 145 nanometers), and the substrate including the dried film was annealed under oxygen in a conventional furnace at 1000EC for one-half hour. The findings were that the thin film BST dielectric layer failed due to shorting. The Joshi Declaration (pages 1 and 2) states "Exhibit A to this Declaration is a curve[3] showing the voltage across a device that was intended to be a thin film BST capacitor." From our review of Exhibit A, we find that the linear plot on the graph evidences shorting of the capacitor having a dielectric made from BST. In addition, the Joshi Declaration states (paragraph 6) that "we often observed a significant problem that the bottom electrode peeled away from the wafer. . .

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[2] Declaration filed August 29, 1997.

[3] Exhibit A, of record, does not show a "curve" as stated in the Joshi Declaration. At the Oral Hearing, appellants were requested to fax a copy of Exhibit A. Appellants' representative so responded. The document received was identical to the document of record in the application, which we find to show a graph containing a linear plot. As the document faxed was identical to the document of record, the fax informally submitted has not been made of record.

. We typically observed these problems in any devices that are annealed at temperatures greater than 900EC." The examiner responds by asserting (answer, page 9) that the example in the Joshi Declaration "does not include the adhesion layer disclosed as necessary in the specification in the middle of page 6" and that (answer, page 9) that "[p]erhaps the peeling noted is due more to the lack of an adhesion layer, rather than the processing temperature." At the outset, we note that the specification does not state that an annealing layer is "necessary." What is actually stated (page 6) is that "[t]here will usually be an adhesion or contact layer . . . . " Appellants assert (reply brief, page 5) that the reason no adhesion layer of titanium was used for the annealing process was that "titanium is known to oxidize and peel to cause shorting at such high anneal temperatures." The Joshi Declaration further states (page 3) that "[a]nnealing at 1100EC for one hour [as in Brandmayr] would destroy substantially every partially built integrated circuit that is exposed to[] these conditions and, particularly, those structures having a bottom electrode." In response, the examiner asserts (answer, page 10) that appellants' specification discloses platinum as a bottom electrode material, and that platinum has a melting point of 1769EC, which is well above the processing temperature of 1100EC disclosed by Brandmayr. We are in agreement with appellants (reply brief, pages 19 and 20) that the Joshi Declaration does not allege melting of the platinum electrode. The Joshi Declaration reports peeling of the electrode at high temperatures, and that peeling is different from melting, though both could result in the destruction of the electrode. We note that the Joshi Declaration used the general processes of the present invention

(except for the high anneal temperature), and not the process of Koyama. This point has not been raised by the examiner and we presume that the examiner accepts the "general processes" of appellants invention relied upon in the Joshi Declaration as sufficiently similar to the "general processes" of Koyama that modifying appellants' process with the high annealing temperatures of Brandmayr's process would reflect modification of Koyama's process with the high annealing temperatures of Brandmayr's process.

The examiner has cited the reference to Wilson (answer, page 5) to address "impossibility arguments raised in the brief." The examiner's position (answer, page 7) is that Wilson teaches (col. 2, lines 45-47) "pressures of up to and above 10,000 psi and temperatures of 750 C or more. This reference is cited only to show that high temperatures and pressures are used in the semiconductor art, as well as in the ceramics art." Appellants respond (reply brief, page 2) by asserting that Wilson "relates to the formation of solid, homogeneous bulk material, not integrated circuits. The solid, homogeneous bulk material in Wilson is a HgTe or CdTe semiconductor material that perhaps is useful as an integrated circuit substrate, but it is not an integrated circuit."

We find that Wilson is directed (col. 1, lines 2 and 3) to an apparatus for producing high quality epitaxially grown semiconductors, (col. 2, lines 45-47) grown in high pressure furnaces that are capable of pressures above 10,000 psi and temperatures of 750EC or more. We find that Wilson is silent as to the fabrication of integrated circuits, and we are in agreement with the examiner (answer, page 7) that

Wilson teaches that high temperatures and pressures are used in the semiconductor art. However, we are in agreement with appellants (reply brief, page 3) that "just because integrated circuits are fabricated on a semiconductor substrate does not mean a completed or partially fabricated integrated circuit can withstand the same temperature and pressure extremes as the substrate by itself."

The examiner further asserts (answer, page 6) that "[t]he dielectric layer in the pending claims could be made by any process at all, whether by sol-gel processing as disclosed, by sputtering as taught by Koyama et al., by deposition of a thick layer of dielectric followed by etching to thin the layer, or by wafer bonding between a semiconductor substrate and an overlying dielectric wafer." We find no evidence of record to support the examiner's statement. We are cognizant of the fact that the references to Koyama and Brandmayr together show each of the "parts" of the invention, to the extent that Brandmayr shows a capacitor having a BST layer with a grain size of less than 100 nanometers. However, none of the cited references applied against the claim by the examiner, nor the processes advanced by the examiner provide a teaching that modification of the process of Koyama would have resulted in a capacitor in an integrated circuit having a grain size of less than 200 nanometers as claimed.

As to the issue of whether the reference to Brandmayr is analogous art, as stated by the court in ***In re Oetiker***, 977 F.2d 1443, 1447, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992) "[i]n order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be in the

field of the applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned." ***See also In re Deminski***, 796 F.2d 436, 442, 230 USPQ 313, 315 (Fed. Cir. 1986). In addition, the court stated in ***In re Clay***, 966 F.2d 656, 659, 23 USPQ2d 1058, 1061 (Fed. Cir. 1992) that "[a] reference is reasonably pertinent if, even though it may be in a different field from that of the inventor's endeavor, it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem." ***See also Wang Laboratories Inc. v. Toshiba Corp.***, 993 F.2d 858, 864, 26 USPQ2d 1767, 1773 (Fed. Cir. 1993). We find that based upon the specific facts of this case, Brandmayr is reasonably pertinent to the problem with which the inventor was concerned because the matter with which it deals, e.g., fabrication of capacitors with a BST layer interposed between two electrodes, logically would have commended itself to an inventor's attention in considering his problem. In the present instance, we are informed by the appellants' specification (pages 1 and 2) in the Background of the Invention that "while the dielectric constant of bulk BST is of the order of 300 to 4000, the dielectric constant of thin films made according to the conventional processes is slightly lower. In addition, appellants' specification (page 10) describes the graphs shown in Figure 6, stating "[i]t is seen that the real part of the dielectric constant reaches a peak of nearly 500 at a value of x = 0.3 as with bulk BST, and that the curve otherwise almost exactly follows the curve for bulk BST." Brandmayr teaches fabricating bulk ceramic capacitors having a dielectric formed of BST, and thus falls at least into the latter category of

the two-pronged test, and logically would have commended itself to an artisan's attention in considering the appellants' problem. Thus, we conclude that Brandmayr is analogous art.

With regard to the issue of whether there is suggestion or motivation to combine the Brandmayr er al. '829 patent with the other references, prior art can be modified or combined to reject claims as ***prima facie*** obviousness as long as there is a reasonable expectation of success. Obviousness does not require absolute predictability. ***In re Merck & Co., Inc.***, 800 F.2d 1091, 1097, 231 USPQ 375, 379 (Fed. Cir. 1986). However, at least some degree of predictability is required. Evidence showing there was no reasonable expectation of success may support a conclusion of nonobviousness. ***See In re Rinehart***, 531 F.2d 1048, 1054, 189 USPQ 143, 148 (CCPA 1976). Brandmayr discloses the fabrication of bulk ceramic capacitors having a dielectric formed of BST. In Brandmayr (col. 2, lines 35-41), BST is subjected to helium gas pressures of 10,000 - 30,000 p.s.i. at 1100E C for about one hour. After cooling, the resultant structure is characterized by a dense, uniform microstructure less than 100 nanometers in size. From our analysis and findings, ***supra***, we conclude that there would have been no reasonable expectation of success that the high temperature and pressure needed to produce the small grain size in the BST layer of Brandmayr, or the processes advanced by the examiner (answer, page 6), applied to the process of Koyama, would have produced the small grain size in a capacitor in an integrated circuit as claimed. One of ordinary skill in the art would not have considered it predictable that the bulk ceramic process of Brandmayr could have been applied to the integrated

circuit capacitor of Koyama and would have produced the less than 200 nanometers grain size set forth in claim 1. We are not saying that it would have been impossible to have produced the claimed less than 200 nanometers grain size in the integrated circuit capacitor of Koyama either through Brandmayr's process or the other processes advanced by the examiner. We find that one of ordinary skill in the art would not have been motivated to have applied the process of Brandmayr, or the other processes advanced by the examiner, to Koyama in an attempt to achieve a grain size of less than 200 nanometers because of a lack of a reasonable expectation of success. None of the references relied upon by the examiner provides a teaching that a grain size of less than 200 nanometers in a capacitor is formed in an integrated circuit.

In addition, with regard to the additional documents relied upon by appellants in support of their position, that have not been argued by the examiner, we need not reach these documents as the rejection advanced by the examiner is insufficient to establish the obviousness of the claimed invention as recited in claim 1. Accordingly, the rejection of claim 1 under 35 U.S.C. § 103 is reversed. As claims 2-13 depend from claim 1 and the references to Miller and McMillan do not overcome the deficiencies of Koyama and Brandmayr, the rejection of claims 2-13 is also reversed.

CONCLUSION

To summarize, the decision of the examiner to reject claims 1-13 under 35 U.S.C. § 103 is reversed.

REVERSED

KENNETH W. HAIRSTON Administrative Patent Judge	)))))) BOARD OF PATENT
JERRY SMITH Administrative Patent Judge	) APPEALS) AND) INTERFERENCES
STUART S. LEVY Administrative Patent Judge	)))))

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DUFT, GRAZIANO & FOREST
1790 - 30TH STREET
SUITE 140
BOULDER , CO 80301-1018