The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

Paper No. 21

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte TAKASHI ONISHI,
EIJI IWAMURA, SEIGO YAMAMOTO,
KATSUTOSI TAKAGI,
and KAZUO YOSHIKAWA

Appeal No. 1998-2948
Application 08/400,861[1]

HEARD: May 10, 2001

Before KRASS, BARRETT, and BLANKENSHIP, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

DECISION ON APPEAL

[1] Application for patent filed March 8, 1995, entitled "Method Of Manufacturing Active Matrix Type Liquid Crystal Display," which claims the foreign filing priority benefit under 35 U.S.C. § 119 of Japanese Application 6-150024, filed June 30, 1994.

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1-6.

We affirm.

BACKGROUND

The invention relates to a method of manufacturing an active matrix liquid crystal display (LCD) which comprises, in part, anodic-oxidizing part or all of an interconnect/electrode film formed of an aluminum alloy containing at least one rare earth element and having a thickness of 200 Å or more.

Claim 1 is reproduced below.

> 1. A method of manufacturing an active matrix liquid crystal display having an interconnect film and a switching element, comprising:
>
> forming an interconnect/electrode film on a substrate by physical vapor deposition;
>
> patterning said interconnect/electrode film; and
>
> anodic-oxidizing part or all of said interconnect/electrode film;
>
> wherein said interconnect/electrode film is formed of an Al alloy containing at least one element selected from the group consisting of rare earth elements in an amount of 0.1 to 10 at%; and
>
> the thickness of said anodic oxidation film is in the range of 200Å or more.

THE PRIOR ART

The Examiner relies on the following prior art:

Kiyota et al. (Kiyota) 5,296,653 March 22, 1994

Yamamoto et al. (Yamamoto)[2] JP 7-45555 February 14, 1995

Hochido et al. (Hochido) JP 6-333926 December 2, 1994

Joshi et al. (Joshi), Aluminum-samarium alloy for interconnections in integrated circuits, J. Vac. Sci. Technol. A 8(3), May/June 1990, pp. 1480-1483.

Lee et al. (Lee), Annealing behavior of Al-Y alloy film for interconnection conductor in microelectronic devices, J. Vac. Sci. Technol. B, Vol. 9, No. 5, September/October 1991, pp. 2542-2547.

Kiyota discloses an active matrix liquid crystal display wherein the interconnect lines are formed of an alloy of aluminum and another element, including iron (Fe), cobalt (Co), copper (Cu), tantalum (Ta), and titanium (Ti), having low resistivity (col. 3, line 62 to col. 4, line 16). Kiyota teaches that the defects due to breakage of the lines can be reduced and "[t]he chemical resistance of the wiring layer of the invention and the adhesivity with an insulating film

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[2] A translation of Yamamoto has been prepared by the U.S. Patent and Trademark Office and accompanies this decision.

formed on the wiring layer can also be increased by oxidizing, boriding, carbonizing or siliciding the surface of the wiring layer of the invention" (col. 6, lines 41-45). Kiyota teaches that "[i]n the case of oxidation, anodization can also be employed" (col. 6, lines 48-49). Thus, Kiyota teaches an anodic oxidation film on the interconnect conductor. It is disclosed that "[t]he surface-treated layer usually has a thickness of 0.1 to 1 µm" (col. 6, lines 54-55), i.e., 1000 Å to 10000 Å.

Lee discloses an aluminum-yttrium (Al-Y) alloy with 0.2 at% Y as an interconnection conductor in integrated circuits. The Al-Y alloy has an electrical resistivity similar to that of pure Al, but the Y is sufficient to minimize the generation and growth of annealing hillocks as compared to pure Al (abstract). Hillocks are surface defects in the form of bumps which can cause fatal problems in integrated circuits (p. 2546).

Hochido discloses an Al-Y alloy containing 0.1 to 0.5 wt% Y (0.03 to 0.14 at% from Lee which discloses that 0.7 wt% is 0.2 at%) as an interconnection film that has "few electromigration [defects?] or hillocks" (abstract).

Joshi discloses that aluminum and its alloys, such as Al-Cu, have been the most common choices for metallization of silicon based integrated circuits, but that most solute additions to metals such as aluminum decrease its electrical conductivity (p. 1480, left col.). Joshi states (p. 1480, left col.): "Addition of elements with low solid solubility is an approach to achieve metallization with improved characteristics without undue deterioration in electrical conductivity." Joshi further states (p. 1480, left col.): "Many rare earth elements such as Ce and Sm have relatively low solid solubilities in aluminum and are potential beneficiaries to the metallization system when added in small quantities." Joshi discloses an Al-1 wt% (0.29 at%) Sm metallization alloy which is sputter deposited. The "Al-Sm metallization exhibits very favorable properties, namely, low resistivity and good thermal stability including hillock growth resistance, for potential integrated circuit applications" (abstract).

Yamamoto discloses electrodes for semiconductors which resist hillock formation and have a specific resistance of 20 μS·cm or below which can be used as electrodes for semiconductors in devices using thin-film transistors like active matrix LCDs (translation, pp. 2, 21). The electrodes "consist of aluminum alloys containing 0.1-10 at% of one, two or more of Fe, Co, Ni, Ru, Rh, Ir or 0.05-15 at% of one, two or more of rare-earth elements as alloying ingredients" (translation, p. 2). The rare earth elements also include Y (translation, p. 10). Yamamoto discloses that a low specific resistance is the most important required characteristic for the electrodes of semiconductors used in large-scale LCDs to prevent signal delay (translation, p. 6). The Al alloy films containing Fe, Co, Ni, Ru, Rh, and Ir or containing a rare earth element "had excellent heat resistance and were hard to cause hillocks in a heating process after film formation (i.e., after the formation of said electrode films) and had a low specific resistance after said heating process" (translation, p. 11).

THE REJECTION

Claims 1-6 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kiyota in view of Hochido, Yamamoto, Joshi, and/or Lee.

We refer to the Final Rejection (Paper No. 5), the Examiner's Answer (Paper No. 11) (pages referred to as "EA__"), the Supplemental Examiner's Answer (Paper No. 14), and the [Second] Supplemental Examiner's Answer (Paper No. 16) for a statement of the Examiner's position, and to the Appeal Brief (Paper No. 10) (pages referred to as "Br__"), the Reply Brief (Paper No. 12) (pages referred to as "RBr__"), the Supplemental Reply Brief (Paper No. 15) (pages referred to as "SRBr__"), and the Second Supplemental Reply Brief (Paper No. 17) (pages referred to as "2dSRBr__") for a statement of Appellants' arguments thereagainst.

OPINION

Only argued limitations and arguments in the brief are addressed

We only address the argued limitations and the arguments which are made in the briefs. See 37 CFR § 1.192(c)(8)(iv) (1996) (brief is required to specify the specific limitations in the rejected claims which are not described in the prior art or rendered obvious over the prior art). Cf. In re Baxter Travenol Labs., 952 F.2d 388, 391, 21 USPQ2d 1281, 1285 (Fed. Cir. 1991) ("It is not the function of this court to examine the claims in greater detail than argued by an appellant, looking for nonobvious distinctions over the prior art."); In re Wiechert, 370 F.2d 927, 936, 152 USPQ 247, 254 (CCPA 1967) ("This court has uniformly followed the sound rule that an issue raised below which is not argued in this court, even if it has been properly brought here by a reason of appeal, is regarded as abandoned and will not be considered. It is our function as a court to decide disputed issues, not to create them."); In re Wiseman, 596 F.2d 1019, 1022, 201 USPQ 658, 661 (CCPA 1979) (arguments must first be presented to the Board before they can be argued on appeal). Therefore, for example, we do not address the limitation that the interconnect/electrode film is formed by physical vapor deposition. Nor do we consider the arguments presented for the first time at the oral hearing.

The prima facie case

Kiyota discloses the claimed subject matter except for the limitation that "said interconnect/electrode film is formed of an Al alloy containing at least one element selected from the group consisting of rare earth elements in an amount of 0.1 to 10 at%" in claim 1. The secondary references to

Hochido, Yamamoto, Joshi, and Lee disclose an aluminum/rare earth metal alloy, with the rare earth element in the claimed proportion, for use as an interconnection conductor in integrated circuits, including as electrodes for thin film transistors in LCDs (Yamamoto), but do not discuss anodic oxidizing the interconnect/electrode film.

Hochido and Lee disclose an aluminum/rare earth element alloy having beneficial properties, especially reduction of undesirable hillock formation, for use as an interconnection conductor in integrated circuits. While it can be reasoned that one of ordinary skill in the art would have been motivated to substitute the aluminum/rare earth element alloy of Hochido or Lee for the aluminum alloy in Kiyota to achieve the stated benefits, there is more specific motivation found in Joshi and Yamamoto. Joshi discloses that addition of elements with low solubility is an approach to achieve metallization with improved characteristics without deterioration in electrical conductivity, as compared to prior art alloys such as Al-Cu, and that rare earth elements have relatively low solubilities in aluminum, so an aluminum/rare earth element alloy would provide improvement over the prior art in interconnection metallization. Since Kiyota discloses an Al-Cu alloy, the same alloy mentioned in Joshi, one of ordinary skill in the art would have been motivated to substitute an aluminum/rare earth element alloy for the Al-Cu alloy in Kiyota given that Joshi teaches that an aluminum/rare earth element alloy provides improved characteristics over prior art Al-Cu (or, at least, teaches that an aluminum/rare earth element alloy can be used in place of Al-Cu metallization alloy). Yamamoto, the best reference, teaches that aluminum/rare earth element alloys may be used alternatively to Al-Fe and Al-Co alloys as electrodes in LCDs. Since Kiyota discloses Al-Fe and Al-Co alloys, one of ordinary skill in the art would have been motivated to substitute an aluminum/rare earth element alloy for the Al-Fe and Al-Co alloys of Kiyota given the teachings of Yamamoto. For these reasons, we conclude that the collective teachings of the references would have suggested the obviousness of substituting an aluminum/rare earth element alloy for the aluminum alloy in Kiyota. The aluminum/rare earth element alloy would still use an anodic oxidation film to increase the chemical resistance during etching as taught by Kiyota. As to claims 2 and 5, Yamamoto discloses an aluminum alloy with 0.05-15 at% rare-earth elements, which includes the claimed range of 1 to 5 at%. As to claims 3 and 6, Kiyota discloses the surface-treated layer, which can be an anodic oxidation film, has a thickness of 0.1 to 1 μm (col. 6, lines 54-55), i.e., 1000 Å to 10000 Å, which satisfies the claimed range of 500 Å or more.

For the reasons stated above, we conclude that the collective teaching of the references is sufficient to establish a prima facie case of obviousness as to claims 1-6 absent a showing of error by Appellants. We address Appellants' arguments as to the correctness of the prima facie case before reaching the obviousness conclusion.

Appellants' arguments

Appellants argue that none of the prior art references, alone or in combination, disclose or suggest anodic-oxidizing an interconnect/electrode film formed of a rare earth-containing aluminum alloy (Br2; RBr1).

We conclude that the collective teachings of the references would have suggested the claimed subject matter to one of ordinary skill in the art for the reasons discussed, supra.

Appellants argue that the only possible anodization described in Kiyota is that specifically taught for the particular aluminum alloys of Kiyota, which do not contain rare earth elements (Br4) and that Kiyota suggests that anodic oxidation is only useful for aluminum alloys with copper, gold, boron, etc. (Br4).

We disagree with the conclusion that because Kiyota teaches anodic oxidation with aluminum alloys not containing rare earth elements, Kiyota suggests that anodic oxidation is only useful for those aluminum alloys. Kiyota discloses that the purposes of the anodic oxidation layer are to increase (1) the chemical resistance of the conductor layer, and (2) the adhesivity with an insulating layer formed on the wiring layer. One of ordinary skill in the art would have been motivated by this teaching to apply anodic oxidation to other aluminum alloy conductors for the same purposes. There is no suggestion that anodic oxidation is in any way limited to the disclosed aluminum alloy conductors or won't work with other aluminum alloy compositions.

Appellants argue that while the secondary references show alloys of aluminum with rare earth elements, none of the secondary references disclose the oxidation or anodic oxidation of such films (Br4). It is further argued that the patentability of the claims is supported by the fact that none of the secondary references, which do disclose aluminum alloy films containing rare earth elements, anodically-oxidize these materials (Br5-6) and "[t]he art thus clearly and distinctly separates what can and cannot be added to aluminum alloys and then anodically-oxidized" (Br6).

It is true that the secondary references do not discuss anodic oxidation of the alloy, but the rejection is based on obviousness and Kiyota is relied on for this limitation. The secondary references to Hochido, Yamamoto, Joshi, and Lee are directed to investigating the mechanical, metallurgical, thermal, and electrical properties of an aluminum/rare earth element alloy composition, not to the use of the composition in a device. Thus, one would not expect to find a discussion of subsequent manufacturing steps, such as anodic oxidation. It is illogical to conclude that because the secondary references do not discuss anodic oxidation, that the references imply the alloys cannot be anodically oxidized.

Appellants argue that none of the references disclose anodic-oxidizing of an interconnect/electrode film containing a rare earth element so as to provide an anodic oxidation film having a thickness in the range of 200 Å or more (Br4; Br5; Br8-9) or 500 Å or more, as recited in claims 3 and 6 (Br9-10).

Kiyota discloses anodically oxidizing an aluminum alloy to a thickness of 1000 Å to 10000 Å for the purposes of increasing the chemical resistance of the conductor layer and the adhesivity with an insulating layer formed on the wiring layer, which meets the thickness limitation. If we are correct that it would have been obvious to substitute an aluminum/rare earth element alloy for the aluminum alloy in Kiyota, the motivation for using an anodic oxidation film and the claimed thickness of the anodically oxidized film is taught in Kiyota.

Appellants argue that the Examiner has not shown that an aluminum/rare earth element alloy will maintain the desirable properties mentioned in the secondary references when it is anodically oxidized (Br5). It is also argued that the Examiner was incorrect in stating that anodically oxidizing an aluminum film containing a rare earth element does not influence the properties of the film, and that the Examiner was incorrect in stating that Appellants had not shown that anodic oxidation would materially affect the properties of the alloy (RBr2).

Since anodic oxidation works on a number of different aluminum alloys in Kiyota, there is no apparent reason why one of ordinary skill in the art would be deterred from anodically oxidizing the aluminum/rare earth element alloys of the secondary references when used in the environment of Kiyota. Obviousness does not require absolute predictability of success.

Appellants argue that the anodic oxidation layer formed on aluminum/rare earth element alloys have a greater dielectric breakdown voltage than layers formed on aluminum/tantalum alloys in Kiyota and one of ordinary skill in the art would have no reason to expect the beneficial results resulting from anodic oxidation of an aluminum/rare earth element alloy (Br6-7). It is argued that the present method provides superior results over aluminum alloys containing tantalum, which is the closest prior art (RBr2; 2dSRBr3).

The rejection is over Kiyota in view of the secondary references. Thus, the discussion of aluminum/tantalum alloys is not relevant. It is sufficient that one of ordinary skill in the art would have been motivated to substitute an aluminum/rare earth element alloy for the aluminum alloy in Kiyota to achieve low specific resistivity to shorten the delay time, which is one of the goals of Appellants' method (e.g., specification, p. 5). The combination need not teach the properties of the anodic oxidation film, which are, in any case, not claimed.

It is argued that breakdown voltage varies in a nonlinear fashion with anodic oxidation film thickness and this relationship was not recognized by the prior art (Br9; Br10). Appellants argue that they have demonstrated the benefits of an anodic oxidation film having a thickness of 200 Å or more (RBr3-4).

The breakdown voltage characteristic is not claimed, nor are any physical properties of the anodic oxidation film claimed. The claims only require an anodic oxidation film thickness of 200 Å or more, as recited in claims 1 and 4, or 500 Å or more, as recited in claims 3 and 6, both of which are met by the range of thicknesses of 1000 Å to 10000 Å in Kiyota.

Appellants argue that Kiyota does not disclose an aluminum alloy containing a rare earth element and, therefore, provides no guidance for the thickness of an anodic oxidation film when the aluminum alloy contains a rare earth element (RBr2-3). It is argued that the secondary references do not disclose anodically-oxidized aluminum/rare earth element films and, thus, fail to suggest the claimed 200 Å or more thickness (RBr3).

This argument is repetitive of earlier arguments. While it is true that Kiyota does not disclose the thickness of the anodic oxidation film for an aluminum alloy containing a rare earth element, one of ordinary skill in the art substituting an aluminum/rare earth element alloy for the aluminum alloy in Kiyota would have been motivated to use the disclosed thickness of anodic oxidation, at least as a starting point. It is not required that Kiyota expressly teach an anodic oxidation thickness for claimed aluminum alloy, which, of course, would be an anticipation. It is sufficient that the collective teachings of the references suggest the claimed subject matter.

The Examiner stated that Appellants have not provided any evidence showing the superiority of the claimed aluminum alloy over that of Kiyota when taken in combination with any of Hochido, Yamamoto, Joshi, or Lee (EA7). We agree with Appellants' response (RBr7) that Appellants are not required to compare the claimed invention to subject matter that does not exist in the prior art. This would be comparing the claimed invention to itself. Nevertheless, the fact that there is an improvement over the closest prior art is not determinative of the obviousness of the claimed subject matter.

Appellants argue that the claimed invention of an aluminum film containing a rare earth element with an anodic oxidation film thickness of greater than 200 Å outperforms the aluminum alloys containing a rare earth element in Hochido, Yamamoto, Joshi, and Lee, that has not been anodically oxidized (RBr8).

This argument attacks the secondary references and does not address the rejection which would have an anodic oxidation film over an aluminum/rare earth element alloy. One cannot show nonobviousness by attacking the references individually where the rejection is based on a combination of references. In re Keller, 642 F.2d 413, 426, 208 USPQ 871, 882 (CCPA 1981).

Appellants argue that the Examiner erred in stating that the applied prior art suggests the present invention because none of the references teach not to anodically oxidize an aluminum alloy containing a rare earth element (RBr8). It is argued that the prior art must suggest anodic oxidizing an aluminum film containing a rare earth element (RBr9).

The Examiner actually stated that "contrary to Appellants' assertion, none of the references of record teach not to anodically oxidize an aluminum alloy containing a rare earth element" (EA7). The purpose of the statement was not that anodic oxidation would have been suggested, but to rebut Appellants' arguments, such as the argument that secondary references do not teach anodic oxidation and "[t]he art thus clearly and distinctly separates what can and cannot be added to aluminum alloys and then anodically-oxidized" (Br6). We disagree with the argument that the prior art must expressly suggest anodic oxidizing an aluminum film containing a rare earth element. If this were so, almost every invention would be nonobvious.

Appellants argue that the Examiner relied upon a statement in Lee regarding minimization of the generation and growth of annealing hillocks in aluminum-yttrium allows for motivation to substitute the Lee alloy for the Kiyota alloy, but that the noted reduction in Lee is relative to pure aluminum, not relative to an alloy of aluminum with tantalum, etc., as used in Kiyota, which removes the motivation to combine the references (SRBr1).

Lee discloses an Al-Y alloy film having an electrical resistivity value similar to pure Al and which also minimizes the generation and growth of hillocks (abstract). The film is disclosed as a candidate for interconnection conductors. One of ordinary skill in the art would have been motivated to use the Al-Y film of Lee for interconnection conductors to achieve the disclosed advantages of such a film, even though the advantages are as compared to pure Al.

Appellants argue that it is improper for the Examiner to use the fact against them that two of the aluminum alloy examples in Kiyota, Al-Fe and Al-Co, are disclosed as inventive examples by Appellants in Tables 1 and 2 on pages 13 and 17 of the specification (2SRBr2-3).

We agree that Appellants' disclosure of Al-Fe and Al-Co, as part of their invention originally, cannot be used as evidence of obviousness.

Appellants argue that Kiyota equates all thickness between 0.1 and 1 micron, and does not realize, as Appellants have shown, that a thickness range of 200 Å or more is superior for an interconnect/electrode film made of anodic-oxidized aluminum/rare earth element alloy (2dSRBr3).

This range of 200 Å or more (claims 1 and 4) or, more particularly, 500 Å or more (claims 3 and 6) is hardly a critical range that distinguishes over the range of 0.1 to 1 μm (1000 Å to 10000 Å) in Kiyota. Appellants' range covers all of the range in Kiyota.

Conclusion

Appellants' arguments are not persuasive of error. The rejection of claims 1-6 is sustained.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED

ERROL A. KRASS Administrative Patent Judge	)	
LEE E. BARRETT Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
HOWARD B. BLANKENSHIP Administrative Patent Judge	)	

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