THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 20

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

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Ex parte YOSHIHIRO MIYAZAWA
and YASUNORI OHKUBO

_____

Appeal No. 96-1805
Application 08/200,432[1]

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HEARD: June 10, 1997

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Before ABRAMS, OWENS and CARMICHAEL, *Administrative Patent Judges*.

ABRAMS, *Administrative Patent Judge*.

DECISION ON APPEAL

[1] Application for patent filed February 23, 1994.

This is an appeal from the decision of the examiner finally rejecting claims 1 and 3 through 21. Claim 2 has been canceled. No claims have been allowed.

The appellants' invention is directed to a method of forming a bonded wafer such as those used in semiconductors. The subject matter before us on appeal is illustrated by reference to claim 1, which reads as follows:

1. A method of wafer bonding for forming a bonded wafer by bonding together wafers with sticking forces of surfaces of said wafers, said method being carried out in cooperation with an apparatus having a chamber with a gas inlet and a gas outlet, a first chuck for holding a first wafer, a second chuck for holding a second wafer and moving said second wafer to said first wafer, said chamber including a pressure application bar for contacting at least one of said first and said second wafers, the method including the steps of:

setting a pressure of gas between said first and said second wafers before starting a sticking of said wafers to be below atmospheric pressure;

filling a space between said first and said second wafers before the start of sticking of surfaces of said wafers with a gas having a lower viscosity than air;

moving said second wafer to face said first wafer and releasing said second wafer from said second chuck, and

applying pressure on said second wafer by said pressure application bar.

THE REFERENCES

The references relied upon by the examiner to support the final rejection are:

Goesele et al. (Goesele)	4,883,215	Nov. 28, 1989
Hoshi et al. (Hoshi)	5,129,827	July 14, 1992
Wells et al. (Wells)	5,131,968	July 21, 1992

Black et al., (Black), "Silicon and Silicon Dioxide Thermal Bonding For Silicon On-Insulator Applications," J. Appl. Phys., 63(8), April 15, 1988, pages 2773-2777.

Haisma et al. (Haisma), "Silicon-On-Insulator Wafer Bonding-Wafer Thinning Technological Evaluations," Japanese Journal of Applied Physics, Vol. 28, No. 8, August 1989, pages 1426-1443.

The appellant's admitted prior art as set forth on page 2, lines 17-21, page 8, line 4-page 9, line 17, and Figures 4A-4D.

THE REJECTIONS

Claims 1, 3 through 17, 20 and 21 stand rejected under 35 U.S.C. § 103 as being unpatentable over the admitted prior art in view of Wells, Hoshi and Black, considered either together or further in view of Goesele.[2]

Claims 9 and 17 through 19 stand rejected under 35 U.S.C. § 103 as being unpatentable over the references cited against claim 1 *et al*. taken further in view of Haisma.

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[2] We note that claim 8, as it appears in the appendix to the Brief, is dependent from claim 2, which has been canceled. However, inspection of Amendment A (Paper No. 6), in which claim 8 first was presented, reveals that it properly depends from claim 1. We also note that a rejection of claims 4 and 5 under 35 U.S.C. § 112, second paragraph, was overcome by an amendment filed after the final rejection (Paper No. 13).

The rejections are explained in the Examiner's Answer.

The opposing viewpoints of the appellants are set forth in the Brief.

OPINION

The examiner has presented two rejections under 35 U.S.C. § 103, each of which relies on the combined teachings of at least four references in order to support the conclusion that the claimed subject matter would have been obvious. The guidance provided us by our reviewing court for evaluation of such rejections is that the test for obviousness is what the combined teachings of the prior art would have suggested to one of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). In establishing a *prima facie* case of obviousness, it is incumbent upon the examiner to provide a reason why one of ordinary skill in the art would have been led to modify a prior art reference or to combine reference teachings to arrive at the claimed invention. See *Ex parte Clapp*, 227 USPQ 972, 973 (BPAI 1985). To this end, the requisite motivation must stem from some teaching, suggestion or inference in the prior art as a whole or from the knowledge generally available to one of

ordinary skill in the art and not from the appellants' disclosure. See, for example, *Uniroyal, Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 1052, 5 USPQ2d 1434, 1439 (Fed. Cir.), *cert. denied*, 488 U.S. 825 (1988).

The appellants' claims all are directed to a method of wafer bonding. Each of the three independent method claims includes a preamble which establishes the environment in which the method is performed as including a chamber with a gas inlet and a gas outlet, means for holding a first wafer, means for holding a second wafer and for moving it to the first wafer, and a pressure application bar for contacting at least one of the wafers. Among the several method steps thereafter recited in all three of these claims is that the space between the two wafers be filled with a gas having a lower viscosity than air "before the start of sticking of surfaces of said wafers" (claims 1 and 13) and "before starting a sticking of surfaces of said wafers" (claim 4). Claims 1 and 13 further require that a pressure of gas "below atmospheric pressure" be set between the two wafers applied "before starting a sticking of surfaces of said wafers."

All three independent claims stand rejected as being unpatentable over the combined teachings of the prior art admitted by the appellants plus Wells, Hoshi and Black, with or

without Goesele. The "admitted prior art" designated by the examiner constitutes portions of the appellants' specification on pages 2 and 8, and the system shown in Figures 4A through 4D. It is here that the appellants discuss methods of bonding utilized in the prior art, and the problems which the appellants believe remain unsolved by them, including the elimination of gas bubbles between the bonded wafers, which is the objective of their invention. Insofar as the requirements set forth in the preamble of claim 1 are concerned, the admitted prior art fails to disclose a chamber with a gas inlet and a gas outlet, as well as a second chuck for holding the second wafer and moving it to the first wafer. The admitted prior art also fails to teach the steps of setting a pressure of gas below atmospheric pressure between the first and second wafers before starting a sticking of the wafers, and filling a space between the first and second wafers before the start of sticking of surfaces of the wafers with a gas having a lower viscosity than air. These inadequacies are admitted by the examiner on page 6 of the Answer.

It is the examiner's position that one of ordinary skill in the art would have understood that some means was necessary for holding the second of the two wafers shown in the appellants'

prior art Figures 4A through 4D, and for moving the second wafer toward the first wafer, that is, from the position shown in Figure 4A to that of Figure 4B, where it is acted upon by the pressure application bar (Figure 4C). As evidence of this, the examiner points to Wells, wherein first and second wafers are held by means of vacuum upon a pair of chucks which are movable

toward one another to effect the bonding operation (Figure 1 and column 1, lines 62 and 63). We agree that these features were known in the art at the time of the appellants' invention. We also agree with the examiner that Wells further teaches that the bonding operation can be accomplished in an enclosure, noting also, however, that the precise teaching of Wells is that this "enclosure" include **all** of the mechanisms for bonding the wafers together, including "scrubbing, spin drying, crystal orientation and joining" (column 4, lines 11 through 15). Also, there is no teaching in Wells that an atmosphere of reduced pressure is provided, or that the enclosure is filled with a gas other than air.

The Hoshi reference is directed to a method for bonding semiconductor wafers in such a manner as to eliminate gas bubbles between the two bonded surfaces. The examiner focuses on the embodiment illustrated in Figures 3A through 3F. In this system, first and second flat wafers 50A and 50B are pulled by vacuum upon a pair of curved chucks 6A and 6B, whereupon they assume a warped configuration (Figures 3A and 3B). Each chuck is mounted in a cover (22A and 22B) and, as shown in Figure 3C, the covers are folded over upon one another to form a chamber having a gas outlet 29. There is no gas inlet. At this point in the Hoshi process, the warped wafers are held spaced from one another. As explained in column 4, chuck 6B then is raised to the position shown in Figure 3D, in which the protruding center portions of the wafers are placed in contact with each other (column 4, line 22). The next step is to subject the interior of the chamber to a vacuum greater than that which holds the wafers upon the chucks, whereupon they are released to flatten and make full contact with one another, as shown in Figure 3E, so that they bond together along their entire surfaces (column 4, lines 25 through 31). This is intended to eliminate the presence of gas bubbles between the bonded wafers.

Black is concerned with preventing voids between bonded wafers which are caused by the presence of particulate or gas. Black specifies that the wafers are made of silicon material. The reference points out that particulate voids can be eliminated by bonding the wafers in a dust-free chamber (page 2773, column 2), and that gas voids between the wafers can be eliminated if the gas between the wafers during the bonding operation "is either capable of combining with the silicon (e.g. oxygen) or diffusing out of the bubble void through the silicon" (page 2776, column 2). In addition to oxygen, the reference mentions hydrogen and helium as being appropriate gases (page 2774, column 1, lines 3 and 4). Black also comments that some wafer pairs were
mated in high vacuum (page 2774, columns 1 and 2). In the conclusion section of the article, after stating that gas voids can be eliminated by combining with the wafer or diffusing through it, it is said that "[m]ating the wafers under high vacuum was <u>also</u> effective" (page 2776, column 2, emphasis added), which would seem to establish that the authors did not contemplate utilizing hydrogen gas plus vacuum conditions in the bonding chamber. This understanding is confirmed by the examiner, who states on page 11 of the Answer that "[t]he use of

a gas ambient as an alternative to the high vacuum is clearly envisioned by Black" (emphasis added). The appellants also support this view (Brief, page 8).

Goesele has been cited by the examiner as teaching that the bonding process can successfully be conducted by pressing the wafers together at one spot, from which a bonding wave proceeds (column 3, lines 34 through 36).

We first shall consider the limitation in claims 1 and 13 of setting a pressure of gas below atmospheric pressure between the first and second wafers "before starting a sticking of said wafers." The examiner's position is that Hoshi would have taught one of ordinary skill in the art to further modify the bonding systems described in the admitted prior art by performing them in a chamber in which the pressure is below atmospheric at the required point in the method. He begins his analysis by asserting that

> no bonding of the wafers [in Hoshi] is initiated by merely contacting the surfaces . . . as depicted in Figure 3D because the wafers are still held apart by the vacuum pressure of the vacuum chucks" (Answer, sentence bridging pages 8 and 9).

After making this finding, the examiner goes on to state that the reduction of pressure in the chamber in Hoshi thus occurs "before" the start of sticking, and meets the terms of claims 1 and 13.

We do not agree with this interpretation of Hoshi even assuming, *arguendo*, that suggestion exists to combine this reference with the others. It is our finding that the contact between the two wafers illustrated in Figure 3D of Hoshi constitutes the starting of the sticking of the wafers. In support of this conclusion, we point out that the Hoshi invention is directed to the type of bonding which is accomplished without using any adhesive, but by mirror-grinding the surfaces and then placing them together in a clean atmosphere (column 1, lines 10 through 15). It therefore follows that contact between the two wafers is, at the very least, the "start" of the sticking (bonding) phenomenon. In fact, there being no further movement of the
portions of the wafers which initially are placed into contact during the rest of the bonding process, it would appear that these portions do, in fact, fully bond at the moment of contact. Since Hoshi clearly teaches that this occurs prior to the vacuum being drawn in the chamber, the reference would not have

suggested to one of ordinary skill in the art that the pressure be reduced before the start of sticking, as is required in claims 1 and 13.

Another of the requirements in these two claims is that the space between the wafers be filled with a gas having a viscosity less than air before the start of sticking. We agree with the examiner that one of ordinary skill in the art would have been taught by Black that the bonding of silicon wafers can be enhanced by doing the process in a hydrogen atmosphere. The problem we find in the rejection is, however, a lack of suggestion to combine in a manner which would meet the terms of the claim. First of all, as we noted above, Hoshi teaches eliminating the problem of gas bubbles remaining between the bonded wafers by holding the wafers in a warped condition and then releasing them to spring into contact with each other, this being done in an environment of reduced pressure. However, as we stated above, according to the record before us reduced pressure

is taught by Black as an <u>alternative</u> to the use of hydrogen gas. This being the case, it is our view that Black would have taught one of ordinary skill in the art to use either reduced pressure or hydrogen gas, but not both together. Second, even

considering, *arguendo*, that it would have been obvious to utilize hydrogen gas in the Hoshi process, there is nothing in Black which would have suggested to one of ordinary skill in the art the additional steps of evacuating the air from the chamber and replacing it with hydrogen prior to Hoshi's teaching of reducing the pressure after contact between the wafers has been made. These two new steps would have been essential to the Hoshi teachings as incorporated into the process disclosed in the admitted prior art.

The other reference cited against claims 1 and 13 fails to alleviate the shortcomings discussed above found in the combination of the admitted prior art, Wells, Hoshi and Black, and therefore it is our view that the combined teachings of the references fail to establish a *prima facie* case of obviousness with regard to the subject matter of independent claims 1 and 13 or, it follows, of claims 3 and 6 through 21, which depend therefrom. The rejection of these claims is, therefore, not sustained.

The language of independent claim 4 is quite similar to claims 1 and 13, except that, while it contains the requirement

that the space between the wafers be filled with a gas of viscosity less than that of air prior to the start of sticking of the wafers, it does not also require the reduced pressure environment. However, as expressed above with regard to the other independent claims, it is our view that the combined teachings of the references fail to establish a *prima facie* case of obviousness with regard to the requirement of filling the space between the wafers with a gas having a lower viscosity than air, on its own. This being the case, we will not sustain the rejection of claim 4 or of dependent claim 5.

The teachings of Haisma, cited against some of the dependent claims, also have been considered, but do not overcome the deficiencies discussed above.

Neither of the rejections is sustained.

The decision of the examiner is reversed.

REVERSED

NEAL E. ABRAMS Administrative Patent Judge	)
TERRY J. OWENS Administrative Patent Judge	) BOARD OF PATENT) APPEALS AND) INTERFERENCES
JAMES T. CARMICHAEL Administrative Patent Judge	)

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