

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

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*Ex parte* SUBRAMANYAM A. IYER,  
VIJAYAKUMAR S. RAMACHANDRARAO,  
and ROBERT B. TURKOT, JR.

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Appeal 2006-2444  
Application 10/342,053  
Technology Center 1700

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Decided: September 20, 2006

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Before PAK, WALTZ, and JEFFREY T. SMITH, *Administrative Patent Judges*.

WALTZ, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on an appeal from the Primary Examiner's final rejection of claims 1 through 3, 8, and 11 through 18, which are the only claims pending in this application. We have jurisdiction pursuant to 35 U.S.C. § 134.

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According to Appellants, the invention is directed to a method of forming a two-phase mixture of supercritical carbon dioxide and liquid co-solvent by using an amount of the co-solvent that exceeds the solubility of said co-solvent in the supercritical carbon dioxide, and subsequently applying this two-phase mixture to remove unwanted material from a semiconductor substrate (Br. 7). Claim 1 is illustrative of the invention and is reproduced below:

1. A method comprising:  
forming a two-phase mixture of supercritical carbon dioxide and liquid co-solvent using an amount of co-solvent that exceeds the solubility of said co-solvent in supercritical carbon dioxide; and  
applying said two-phase mixture to remove unwanted material from a semiconductor substrate.

The Examiner has relied upon the following references as evidence of obviousness:

Subramaniam	US 5,874,029	Feb. 23, 1999
McClain	US 6,030,663	Feb. 29, 2000
Schilling	US 2004/0112409	Jun. 17, 2004

Claims 1, 3, and 8-16 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Schilling as “evidenced by” McClain (Answer 2).<sup>1</sup> Claims 2, 17, and 18 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Schilling as evidenced by McClain, further in view of Subramaniam (Answer 4).

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<sup>1</sup> We note that this rejection includes claims 9-10 which were previously cancelled (Br. 5). In our review of this rejection, we consider only pending claims 1, 3, 8, and 11-16.

Based on the totality of the record, we AFFIRM all grounds of rejection on appeal essentially for the reasons stated in the Answer as well as those reasons set forth below.

#### OPINION

##### A. The Rejection over Schilling and McClain

With regard to claim 1 on appeal, the Examiner finds that Schilling discloses a method of forming a mixture of supercritical carbon dioxide and liquid co-solvent and teaches applying this mixture to remove unwanted material from a semiconductor substrate (Answer 2). The Examiner further finds that Schilling does not expressly teach the use of a concentration of co-solvent that exceeds the solubility of the co-solvent in the supercritical carbon dioxide, thus forming a two-phase mixture (Answer 3). However, the Examiner concludes that it would have been obvious to one of ordinary skill in this art at the time of the invention to determine the optimum concentration of co-solvent necessary to achieve effective cleaning (*id.*). Additionally, the Examiner applies McClain as evidence that it was known in this art to employ a co-solvent with supercritical carbon dioxide in multiphase systems (*id.*). We note that Appellants present no specific argument concerning McClain (see the Brief and Reply Brief in their entirety).

Appellants argue that there is no rationale presented to modify the single reference to Schilling, and that it would be counterintuitive to the artisan to exceed the solubility of the co-solvent (Br. 10; Reply Br. 2).

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Appellants argue that nothing in the prior art suggests exceeding the solubility limit of the co-solvent in the supercritical carbon dioxide (Reply Br. 2).

Appellants' arguments are not persuasive. Contrary to Appellants' argument that exceeding the solubility limit is "counterintuitive," we agree with the Examiner that one of ordinary skill in the art would have selected the co-solvent based on its function (i.e., its ability to clean and act as a carrier) and optimized the amount necessary to achieve the best results (Answer 5-6). Additionally, since the amount of co-solvent necessary for exceeding the solubility to form a two-phase mixture can be a minuscule amount more than the concentration to achieve full solubility, this very small difference in amount would have been expected to produce the same results and thus would have been *prima facie* obvious, absent a showing of unexpected results. *See Titanium Metals Corp. v. Banner*, 778 F.2d 775, 783, 227 USPQ 773, 779 (Fed. Cir. 1985). *See also In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990) ("The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. [Citations omitted]. These cases have consistently held that in such a situation, the applicant must show that the particular range is *critical...*").

With regard to claim 8 on appeal, the Examiner finds that Schilling teaches a method of exposing the substrate to the cleaning mixture, rinsing the substrate, and re-exposing the substrate to the cleaning mixture

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(Answer 4). The Examiner recognizes that Schilling fails to explicitly teach re-exposing the substrate to the cleaning mixture at a concentration different than that used for the first exposure (*id.*). However, the Examiner finds that Schilling teaches the use of various chemistries in both the rinsing and cleaning processes (*id.*). From these findings, the Examiner concludes that it would have been obvious to one of ordinary skill in this art to re-expose the substrate using the same or different chemistry or concentration in order to remove the unwanted material on the substrate (*id.*).

Appellants argue that the Examiner’s citation of Fig. 8 and paragraph 59 from Schilling discloses nothing about concentrations (Br. 11). Appellants submit that the Examiner does not address the limitations of claim 8 (Reply Br. 2).

We do not find Appellants’ arguments persuasive. We determine that the Examiner has adequately addressed the limitations of claim 8 on appeal in the Answer (Answer 4 and 6). We find that Schilling is replete with teachings to re-expose the substrate to the cleaning mixture until the unwanted material is removed from the substrate (e.g., p. 2, ¶ [0016]). We find that Appellants have not defined the term “different” in claim 8 on appeal and, thus, this term includes concentrations which differ only by a minuscule amount. As discussed above, employing a step at a concentration which may be only slightly different has been held to be *prima facie* obvious, with the expectation of similar results, absent a showing of criticality. *See Titanium Metals Corp. v. Banner, supra.*

With regard to claim 11, the Examiner finds that Schilling teaches exposing the substrate with a material to be removed to the cleaning mixture of supercritical carbon dioxide and the co-solvent, rinsing the substrate with organic solvents, and then re-exposing the substrate to the cleaning mixture (Answer 3).

Appellants argue that Schilling does not teach any use of different rinse steps using different chemistries (Br. 11; Reply Br. 2). This argument is not well taken since claim 11 does not require different chemistries, but merely requires a second concentration that is the “same or different” from the first concentration (Answer 7). With regard to the limitations of claim 12 on appeal (Reply Br. 3), we agree with the Examiner that Schilling teaches the use of various cleaning and rinse cycles as necessary to remove the unwanted material (for cleaning) and trace amounts of remaining residue (for rinsing). See Schilling, ¶ [0016], [0017], [0057 – 0060], and [0071]. As discussed above, the use of slightly different concentrations in either the cleaning mixture or the rinse solution would have been expected by one of ordinary skill in this art to achieve similar results, absent any showing of criticality.

For the foregoing reasons and those stated in the Answer, we determine that the Examiner has established a prima facie case of obviousness in view of the reference evidence. Based on the totality of the record, including due consideration of Appellants’ arguments, we determine that the preponderance of evidence weighs most heavily in favor of

obviousness within the meaning of § 103(a). Therefore, we AFFIRM the rejection of claims 1, 3, 8, and 11-16 under § 103(a) over Schilling as evidenced by McClain.

B. The Rejection over Schilling, McClain, and Subramaniam

The Examiner applies Schilling and McClain as discussed above but recognizes that these references do not expressly teach forming the cleaning mixture by suspending droplets of the co-solvent in the supercritical carbon dioxide (Answer 4-5). Therefore, the Examiner applies Subramaniam as evidence that it was well known in the “chemical mixing art” to mix or disperse a liquid in a gas using a spray or droplet means to form an evenly distributed mixture (Answer 5). From these findings, the Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to form suspended droplets of co-solvent in the supercritical fluid cleaning mixture of Schilling in order to achieve an evenly distributed mixture, as taught by Subramaniam (*id.*).

Appellants argue that Subramaniam does not disclose or suggest forming liquid droplets for purposes of exposing a material to be removed from a semiconductor surface but, instead, forms droplets to cause depletion of the solvent in the droplets to obtain smaller particles from the solute (Br. 12). Accordingly, Appellants argue that there is no reason to combine the references (*id.*).

Appellants’ arguments are not persuasive. Appellants have not disputed the Examiner’s finding that it was well known in the chemical

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mixing art to disperse a liquid in a gas using a spray or droplet means to form an evenly distributed mixture. Appellants' argument is not well taken since Subramaniam need not be directed to a cleaning mixture for removing unwanted material from a semiconductor substrate, but need only be directed to an improved method of distributing a liquid in a supercritical gas.

For the foregoing reasons and those stated in the Answer, we determine that the Examiner has established a prima facie case of obviousness in view of the reference evidence. Based on the totality of the record, including due consideration of Appellants' arguments, we determine that the preponderance of evidence weighs most heavily in favor of obviousness within the meaning of § 103(a). Therefore we AFFIRM the rejection of claims 2, 17, and 18 under § 103(a) over Schilling as evidenced by McClain and further in view of Subramaniam.

C. Summary

The decision of the Examiner 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).

AFFIRMED

clj

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