UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HARUHIRO HARRY GOTO,
WILLIAM R. HARSHBARGER, and KAM S. LAW

Appeal 2007-1884
Application 10/329,205
Technology Center 1700

Decided: June 13, 2007

Before EDWARD C. KIMLIN, CHUNG K. PAK, and
CHARLES F. WARREN, *Administrative Patent Judges*.

KIMLIN, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal from the final rejection of claims 8 and 10-12.

Claim 8 is illustrative:

8. A process for selectively etching silicon from a workpiece without etching silicon oxide or silicon nitride, comprising the simultaneous steps of:

holding a workpiece comprising silicon on a susceptor within a chamber interior;

heating the susceptor to about 450°C; and

supplying molecular fluorine gas to the chamber interior while sealing the chamber interior to prevent any gas other than said molecular fluorine gas from entering the chamber interior;

wherein the molecular fluorine gas is not excited to a plasma state.

The Examiner relies upon the following references as evidence of obviousness:

Takenaka US 6,077,451 Jun. 20, 2000

J.A. Mucha et al., "Chemiluminescence and the Reaction of Molecular Fluorine with Silicon," 85 J. Phys. Chem. no. 23, 3529-32 (1981)

I.A. Badmaeva et al., "Reaction Velocity Constants of Ge and Si Interaction with Atomic and Molecular Fluoride and Xenon Diflioride," Poverhnost', Fizika, Khimiya, Mekanika no. 8, 92-97 (1989)

Masayuki Hiroi and Toru Tatsumi (hereafter "Hiroi"), "Temperature Dependence of Etching with Molecular Fluorine on Si(111) Surface," 33 Jpn. J. Appl. Phys. no. 4B, 2244-47 (1994)

Appellants' claimed invention is directed to a process for selectively etching silicon from a workpiece. The process entails holding the workpiece on a susceptor and heating the susceptor to about 450°C within the interior of a chamber, and supplying molecular fluorine gas to the chamber. The molecular fluorine gas is not excited to a plasma state.

Appealed claims 8 and 10-12 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mucha, Badmaeva, and Hiroi in view of Takenaka.

Appellants have not set forth an argument that is reasonably specific to any particular claim on appeal. Accordingly, all the appealed claims stand or fall together with claim 8.

We have thoroughly reviewed each of Appellants' arguments for patentability. However, we are in complete agreement with the Examiner that the claimed subject matter would have been obvious to one of ordinary skill in the art within the meaning of § 103 in view of the applied prior art. Accordingly, we will sustain the Examiner's rejection for essentially those reasons expressed in the Answer, and we add the following primarily for emphasis.

We concur with the Examiner that Mucha, Badmaeva, and Hiroi establish that it was known in the art that molecular fluorine gas can be used to etch silicon, and that temperature is a result-effective variable regarding the effectiveness of the etching. In particular, Mucha expressly discloses that etching depths for silicon varied from 2,000 to 75,000 angstroms, depending on the temperature, pressure, and time. Mucha also discloses that molecular fluorine produces a rougher edge than atomic fluorine (Mucha 3530, col. 1, last para.). In addition, Mucha teaches that molecular fluorine preferentially etches silicon versus SiO_2 to a greater extent than atomic fluorine (Mucha 3530, col. 2, third para.). Hiroi also discloses that molecular fluorine etches silicon below 580°C. Likewise, Badmaeva teaches that molecular fluorine etching of silicon is contingent upon temperature. Accordingly, we find that the prior art cited by the Examiner

firmly establishes that it was known in the art to etch silicon with molecular fluorine at elevated temperatures. Also, significantly, none of Mucha, Hiroi, or Badmaeva discloses that molecular fluorine is in plasma form during the etching of silicon.

As appreciated by the Examiner, Mucha, Hiroi, and Badmaeva do not expressly teach that the elevated temperature within the chamber is effected by heating the susceptor. However, as pointed out by the Examiner, Takenaka evidences that it was known in the art to heat the susceptor during silicon etching at elevated temperatures. Consequently, although Takenaka utilizes fluorine compounds, but not molecular fluorine, we are satisfied that one of ordinary skill in the art would have found it obvious to raise the temperature of the chamber for etching silicon by heating the susceptor, regardless of the particular etching gas employed. Appellants have apprised us of no reason why the particular etching gas used would have played a role in the means selected for heating the etching chamber.

Appellants maintain that the combination of references does not teach heating the susceptor to about 450°C. However, Hiroi specifically teaches etching silicon with molecular fluorine at a temperature below 580°C, which encompasses the claimed value. Moreover, as explained by the Examiner, it is a matter of obviousness for one of ordinary skill in the art to determine the optimum value of a result-effective variable, such as temperature, in the etching of silicon with molecular fluorine. Also, the Examiner correctly points out that Appellants' Specification attaches no criticality to the

claimed temperature value, stating that "[a]lthough the silicon etch process was tested only at a substrate temperature of about 385°C (a susceptor temperature of 450°C), the temperature need not be that high" (Specification 2, last para.). The Specification goes on to state that "[i]t is a matter of routine experimentation to determine the minimum temperature to which a substrate or workpiece must be elevated in order to cause the molecular fluorine gas to react with and remove a silicon layer exposed on the substrate" (*id*.).

We also do not subscribe to Appellants' position that Hiroi's discussion of the prior art silicon etching with fluorocarbon plasmas indicates that the molecular fluorine etch disclosed is also in the plasma state. Hiroi simply states that the prior art employed fluorocarbon plasmas, but provides no teaching that the molecular fluorine etchant is in the plasma state. Conspicuously absent is any discussion of using molecular fluorine plasma.

As a final point, we note that Appellants base no argument upon objective evidence of nonobviousness, such as unexpected results, which would serve to rebut the inference of obviousness established by the Examiner.

In conclusion, based on the foregoing and the reasons well stated by the Examiner, the Examiner's decision rejecting the appealed claims 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) (2006).

AFFIRMED

clj

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