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Paper 10
Entered: June 9, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICRON TECHNOLOGY, INC., INTEL CORPORATION, and
GLOBALFOUNDRIES U.S., INC.,
Petitioners,

v.

DANIEL L. FLAMM,
Patent Owner.

Case IPR2017-00406
Patent 5,711,849

Before CHRISTOPHER L. CRUMBLEY, JO-ANNE M. KOKOSKI, and KIMBERLY McGRAW, *Administrative Patent Judges.*

KOKOSKI, *Administrative Patent Judge.*

DECISION
Institution of *Inter Partes* Review
37 C.F.R. § 42.108

I. INTRODUCTION

Micron Technology, Inc., Intel Corporation, and GLOBALFOUNDRIES U.S., Inc. (collectively, "Petitioner") filed a Petition ("Pet.") to institute an *inter partes* review of claims 1–29 of U.S. Patent No. 5,711,849 ("the '849 patent," Ex. 1001). Paper 1. Daniel L. Flamm ("Patent Owner") filed a Preliminary Response ("Prelim. Resp."). Paper 9. We have jurisdiction under 35 U.S.C. § 314.

Upon consideration of the Petition, Preliminary Response, and the evidence of record, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing with respect to the unpatentability of at least claim 1 of the '849 patent. As such, we exercise our discretion to have the review proceed on all the challenged claims. Accordingly, we institute an *inter partes* review of claims 1–29 of the '849 patent.

A. Related Proceedings

The parties indicate that the '849 patent is at issue in five related patent infringement actions. Pet. 4; Paper 7, 2. The '849 patent previously was the subject of IPR2016-00466 (filed by Lam Research Corp., institution denied on July 19, 2016), and currently is the subject of IPR2017-00392, also filed by Petitioner. Pet. 5.

B. The '849 Patent

The '849 patent, titled "Process Optimization in Gas Phase Dry Etching," is directed to "a plasma etching method that includes determining a reaction rate coefficient based upon etch profile data." Ex. 1001, 1:51–53. The method "includes steps of providing a plasma etching apparatus having a substrate therein[,]" where the substrate has a film overlaying the top surface, and the film has a top film surface. *Id.* at 1:59–63. It "also includes chemically etching the top film surface to define an etching profile on the film, and defining etch rate data which includes an etch rate and a spatial coordinate from the etching profile." *Id.* at 1:63–67. Steps of extracting a reaction rate constant from the etch rate data, and using the reaction rate constant to adjust the plasma etching apparatus are also described. *Id.* at 1:67–2:2. According to the '849 patent, the method "provides for an easy and cost effective way to select appropriate etching parameters such as reactor dimensions, temperature, pressure, radio frequency (rf) power, flow rate and the like by way of the etch profile data." *Id.* at 1:53–57.

Figure 1A of the '849 patent is reproduced below:

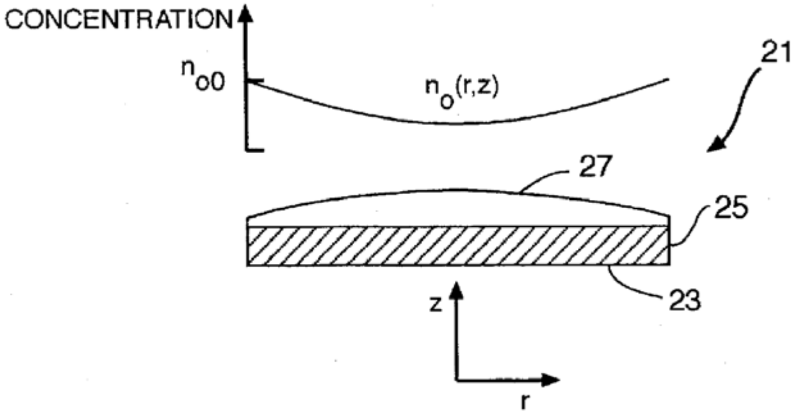

FIG. 1A

Figure 1A is an example of an etched substrate. *Id.* at 3:66–67. Substrate 21 includes bottom surface 23, sides 25, and top surface film 27, and is defined in spatial coordinates z and r. *Id.* at 3:67–4:2. "[T]op surface film [27] includes a convex region, or etching profile." *Id.* at 4:3–4. "The etching profile occurs by way of different etch rates along the r-direction of [substrate 21], corresponding to different etchant species concentrations." *Id.* at 4:4–6. Concentration profile $n_o(r,z)$ shows that "the greatest concentration of reactant species exists at the outer periphery of [] top surface film [27]." *Id.* at 4:6–9.

The ’849 patent describes an embodiment of a method of extracting an etch rate constant in which a substrate with an overlying film is placed into a plasma etching apparatus, and the plasma etching step occurs at constant pressure, and, preferably, isothermally. *Id.* at 5:11–19. Plasma etching of the film stops before etching into an etch stop layer underneath the overlying film “in order to define a ‘clean’ etching profile.” *Id.* at 5:24–26. The plasma etching step produces an etching profile, which “converts into a relative etch rate, relative concentration ratio, a relative etch depth and the like at selected spatial coordinates.” *Id.* at 5:28–32.

Using x-y-z coordinates, the relative etch rate is in the z-direction, and x-y are the spatial coordinates. *Id.* at 5:38–40. “The etching profile is thereby characterized as a relative etch rate u, [an] x-location, and a y-location u, (x, y),” and an array of data points in the x-y coordinates define the etching profile. *Id.* at 5:40–41, 45–47. An etch constant over diffusivity (k_{vo}/D) and an etch rate at the substrate edge is then calculated, where “[t]he etch constant over diffusivity correlates with data points representing the etch rate profile.” *Id.* at 5:62–65. After the etch rate constant k_{vo} is extracted, the surface reaction rate constant k_s can be determined using the formula $k_s = (k_{vo})d_{gap}$, where d_{gap} is the space above the substrate, between the substrate and the adjacent substrate. *Id.* at 3:35–36, 6:58–62, 9:27–29, Fig 7.

C. Challenged Claims

Petitioner challenges claims 1–29 of the ’849 patent. Claims 1, 10, 20, 22, and 26 are independent. Claim 1 is illustrative, and reads as follows:

> 1. A device fabrication method comprising the steps of:
>
> providing a plasma etching apparatus comprising a substrate therein, said substrate comprising a top surface and a film overlying said top surface, said film comprising a top film surface;
>
> etching said top film surface to define a relatively non-uniform etching profile on said film, and defining etch rate data comprising an etch rate and a spatial coordinate which defines a position within said relatively non-uniform etching profile on said substrate, said etching comprising a reaction between a gas phase etchant and said film; and
>
> extracting a surface reaction rate constant from said etch rate data, and using said surface reaction rate constant in the fabrication of a device.

Ex. 1001, 17:35–50.

D. The Prior Art

Petitioner relies on the following prior art references:

Reference	**Description**	**Date**	**Exhibit No.**
Galewski	*Modeling of a High Throughput Hot-Wall Reactor for Selective Epitaxial Growth of Silicon,* IEEE Transaction on Semiconductor Manufacturing, Vol. 5, No. 3 (1992) 169–179	Aug. 1992	1007
Alkire	*Transient Behavior during Film Removal in Diffusion-Controlled Plasma Etching,* J. Electrochem. Soc.: Solid-State Science and Technology, Vol. 132, No. 3 (1985) 648–656	March 1985	1005

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