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Paper No. 34
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICRON TECHNOLOGY, INC.,
INTEL CORPORATION, GLOBALFOUNDRIES U.S., INC., and
SAMSUNG ELECTRONICS COMPANY, LTD.,
Petitioner,

v.

DANIEL L. FLAMM,
Patent Owner.

Case IPR2017-00392[1]
Patent 5,711,849

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

KOKOSKI, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. §42.73

[1] Samsung Electronics Company, Ltd. was joined as a party to these proceedings via a Motion for Joinder in IPR2017-01747.

I. INTRODUCTION

We have jurisdiction to conduct this *inter partes* review under 35 U.S.C. § 6, and this Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–29 of U.S. Patent No. 5,711,849 ("the '849 patent," Ex. 1001) are unpatentable.

A. Procedural History

Micron Technology, Inc., Intel Corporation, and GLOBALFOUNDRIES U.S., Inc. (collectively, "the Micron Petitioners")[2] filed a Petition ("Pet.") to institute an *inter partes* review of claims 1–29 of the '849 patent based on the following grounds:

References	**Basis**	**Challenged Claims**
Alkire[3] and Kao[4]	§ 103	1–29
Alkire, Kao, and Flamm[5]	§ 103	1–29

[2] On September 15, 2017, we granted the Motion for Joinder filed by Samsung Electronics Company, Ltd. ("Samsung") in IPR2017-01747, and authorized Samsung to participate in this proceeding only on a limited basis. *See* Paper 13. We refer to Micron Technology, Inc., Intel Corporation, GLOBALFOUNDRIES U.S., Inc., and Samsung collectively as "Petitioner" throughout this Decision.

[3] *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 (Ex. 1005).

[4] *Analysis of Nonuniformities in the Plasma Etching of Silicon with CF_4/O_2*, J. Electrochemical Soc., Vol. 137, No. 3 (1990) 954–960 (Ex. 1006).

[5] *The Reaction of Fluorine Atoms with Silicon*, J. Appl. Phys., Vol. 52, No. 5 (1981) 3633–3639 (Ex. 1007).

Paper 1, 5–6. Daniel L. Flamm ("Patent Owner") filed a Preliminary Response ("Prelim. Resp."). Paper 9. Pursuant to 35 U.S.C. § 314(a), we instituted an *inter partes* review of claims 1–29 based on our determination that the information presented in the Petition demonstrated a reasonable likelihood that Petitioner would prevail on its challenge that at least one of the challenged claims is unpatentable under 35 U.S.C. § 103 as obvious over the combined teachings of Alkire and Kao. Paper 10 ("Dec. on Inst."), 19. We subsequently modified our institution decision to include "all of the grounds presented in the Petition." Paper 32, 2.

After institution of trial, Patent Owner filed a Patent Owner Response (Paper 12, "PO Resp."), and Petitioner filed a Reply (Paper 14, "Reply"). Petitioner relies on the Declaration of Dr. David Graves ("the Graves Declaration," Ex. 1003) and the Reply Declaration of Dr. David Graves ("the Graves Reply Declaration," Ex. 1024). Patent Owner relies on the Declaration of Daniel L. Flamm ("the Flamm Declaration," Ex. 2003). An oral hearing was held on March 7, 2018. A transcript of the hearing is included in the record. Paper 31.

B. 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 IPR2017-00406, also filed by the Micron Petitioners (and joined by Samsung). Pet. 4.

C. 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 an 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:

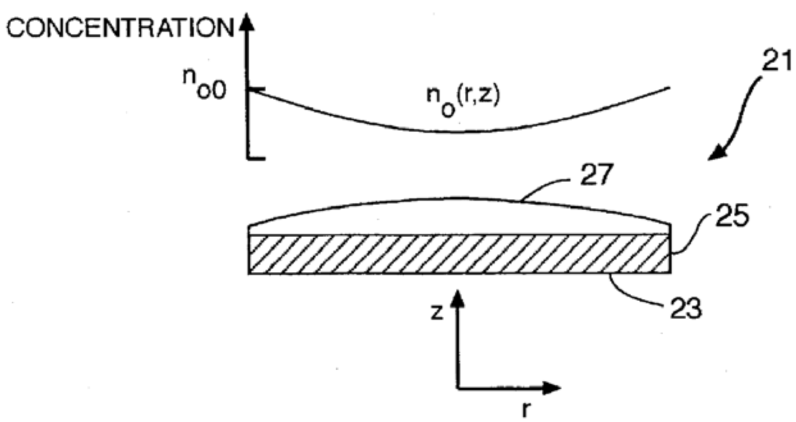

FIG. 1A

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.

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