

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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NANYA TECHNOLOGY CORP.,  
Petitioner,

v.

NORTH STAR INNOVATIONS INC.,  
Patent Owner.

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Case IPR2016-00965  
Patent 6,372,638 B1

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Before J. JOHN LEE, CHARLES J. BOUDREAU, and  
MICHELLE N. WORMMEESTER, *Administrative Patent Judges*.

WORMMEESTER, *Administrative Patent Judge*.

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

Nanya Technology Corp. (“Petitioner”) filed a Petition (Paper 1, “Pet.”) requesting *inter partes* review of claims 1–11 of U.S. Patent No. 6,372,638 B1 (Ex. 1001, “the ’638 patent”). North Star Innovations Inc. (“Patent Owner”) did not file a Preliminary Response. We have jurisdiction under 35 U.S.C. § 314 and 37 C.F.R. 42.4(a). Under 35 U.S.C. § 314(a), an *inter partes* review may not be instituted “unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” For the reasons that follow, we institute an *inter partes* review as to claims 1–11 of the ’638 patent.

## I. BACKGROUND

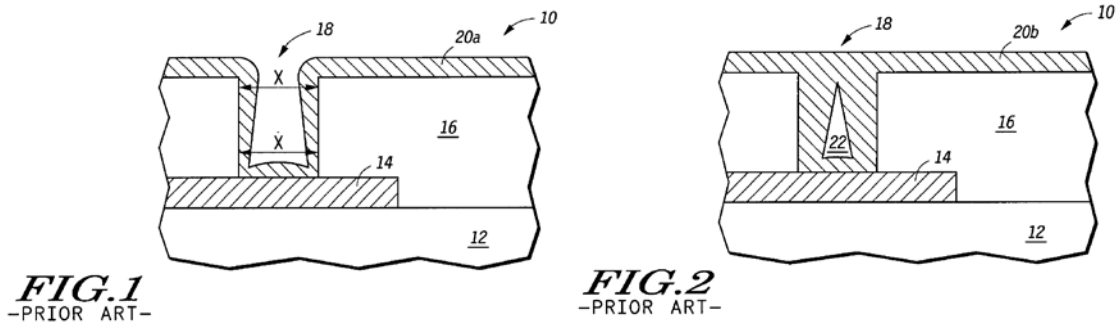
### A. *Related Proceedings*

The parties identify the following related case: *North Star Innovations Inc. v. Nanya Technology Corp.*, Case No. 1:15-cv-01027-GMS (D. Del. Nov. 5, 2015). Pet. v; Paper 7, 2.

Patent Owner also identifies the following related request for *inter partes* review: IPR2016-01022. Paper 7, 2.

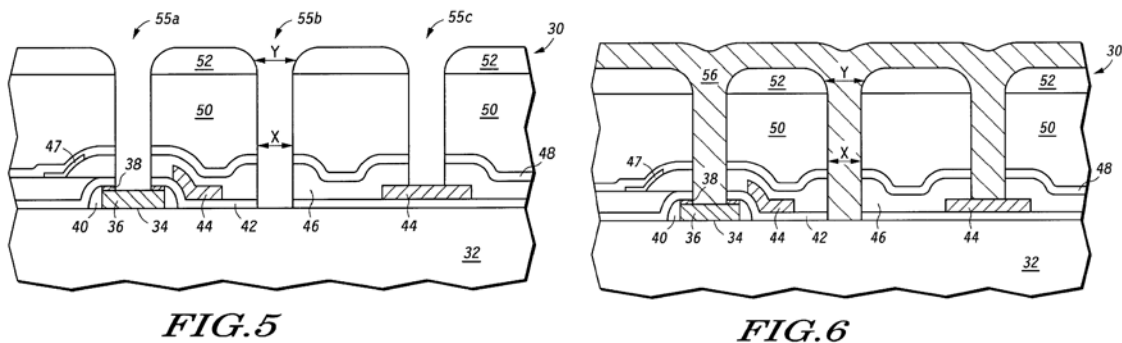
### B. *The ’638 Patent*

The ’638 patent is titled “Method for Forming a Conductive Plug Between Conductive Layers of an Integrated Circuit.” Ex. 1001, at [54]. According to the ’638 patent, tungsten deposition in the integrated circuit industry has become highly nonconformal, resulting in the problem of inconsistent step coverage. *Id.* at 1:30–32. To illustrate this problem, Figures 1 and 2 of the ’638 patent are reproduced below.



Figures 1 and 2 show, in cross-sectional diagrams, a method for forming a contact structure. *Id.* at 2:16–18. The top surfaces of dielectric layer 16 accumulate tungsten material 20a at a much faster rate than the bottom corners of contact opening 18. *Id.* at 1:46–48, Fig. 1. Due to this nonconformal deposition, the contacts end up with keyholes or voids 22. *Id.* at 1:59–61, Fig. 2.

To address this problem, the '638 patent proposes a method for forming tungsten plug contacts that are free of keyholes or voids. *Id.* at 2:28–29. According to one embodiment of the '638 patent, the method alters the contact profile, tapering the sidewalls of the contact to form a “golf tee” profile. *Id.* at 2:37–39. Figures 5 and 6 of the '638 patent, which illustrate such a profile, are reproduced below.



Figures 5 and 6 show, in cross-sectional diagrams, a method for forming a contact structure without keyholes or voids. *Id.* at 2:19–21. The method tapers the upper portions of contact openings 55a–55c. *Id.* at 4:9–12. This tapering step enlarges the upper portions of contacts 55a–55c to radius Y, which is greater than radius X. *Id.* at 4:20–24. Radius X of Figure 5 and radius X of Figure 1 are the same. *Id.* at 4:24–25. As a result of the golf tee profiles, keyholes and voids within the contact openings are reduced or eliminated. *Id.* at 5:25–30.

### *C. Illustrative Claim*

Petitioner challenges claims 1–11 of the '638 patent. Claims 1, 8, and 11 are independent. Claim 1 is illustrative of the claims under challenge:

1. A method for forming a contact structure, the method comprising the steps of:

forming a first conductive material overlying a semiconductor substrate;

forming a dielectric layer overlying the first conductive layer;

forming a resist layer over the dielectric layer;

patterning the resist layer to form an opening that exposes portions of the dielectric layer;

placing the semiconductor substrate into a reactive ion etching chamber and in-situ processing the semiconductor substrate as follows:

etching portions of the dielectric layer using a gas mixture that includes a fluorocarbon source gas to form an opening in the dielectric layer, the opening having a bottom portion and a sidewall portion;

etching a portion of the resist layer using a gas mixture that includes a fluorocarbon source gas and an oxygen source gas to remove the portion of the resist layer and

expose a top surface portion of the dielectric layer adjacent the sidewall portion;

etching the top surface portion of the dielectric layer adjacent the sidewall portion to form a taper that extends between a top surface of the dielectric layer and the sidewall portion, wherein the taper towards the top surface portion has a radius Y and the taper towards the sidewall portion has a radius X wherein  $X < Y$ ; and

removing remaining portions of the resist layer;

depositing a second conductive material within the opening;  
and

polishing away a top portion of the conductive material and a top portion of the dielectric layer to remove the taper.

#### *D. Asserted Grounds of Unpatentability*

Petitioner challenges claims 1–11 of the '638 patent on the following grounds. Pet. 2, 34–84.

Reference(s)	Basis	Claim(s) Challenged
Mathews <sup>1</sup>	§ 102	8–11
Mathews	§ 103	8–11
Mathews and Langley <sup>2</sup>	§ 103	1–7 and 11
Mathews, Langley, and Wu <sup>3</sup>	§ 103	1–7 <sup>4</sup>

<sup>1</sup> Mathews, U.S. Patent No. 5,580,821, issued Dec. 3, 1996 (Ex. 1004).

<sup>2</sup> Langley, U.S. Patent No. 4,939,105, issued July 3, 1990 (Ex. 1005).

<sup>3</sup> Wu, U.S. Patent No. 5,547,892, issued Aug. 20, 1996 (Ex. 1006).

<sup>4</sup> For the ground based on Mathews, Langley, and Wu, Petitioner identifies claims 1–7 and 11 in its summary of the asserted grounds on page 2 of the Petition, but omits claim 11 from the heading on page 78 of the Petition. Given the substance of Petitioner's arguments, we presume the former to be a typographical error, and, therefore, we address only claims 1–7 with respect to this ground.

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