(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 March 2010 (04.03.2010)

PCT

(10) International Publication Number
WO 2010/025357 A3

(51) International Patent Classification:
H01L 21/205 (2006.01)

(21) International Application Number:
PCT/US2009/055349

(22) International Filing Date:
28 August 2009 (28.08.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12/202,126 29 August 2008 (29.08.2008) US

(71) Applicant *(for all designated States except US)*: **NOVELLUS SYSTEMS, INC.** [US/US]; 3970 North First Street, San Jose, California 95134 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **CHEN, Feng** [CN/US]; 1852 Grand Teton Drive, Milpitas, California 95035 (US). **HUMAYUN, Raashina** [IN/US]; 784 Nodaway Avenue, Fremont, California 94539 (US). **MANOHAR, Abhishek** [IN/US]; 510 Mansion Court, Apt. 112, Santa Clara, California 95054 (US).

(74) Agents: **WEAVER, Jeffrey, K.** et al.; Weaver Austin Villeneuve and Sampson LLP, P. O. Box 70250, Oakland, California 94250-0250 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: METHOD FOR REDUCING TUNGSTEN ROUGHNESS AND IMPROVING REFLECTIVITY

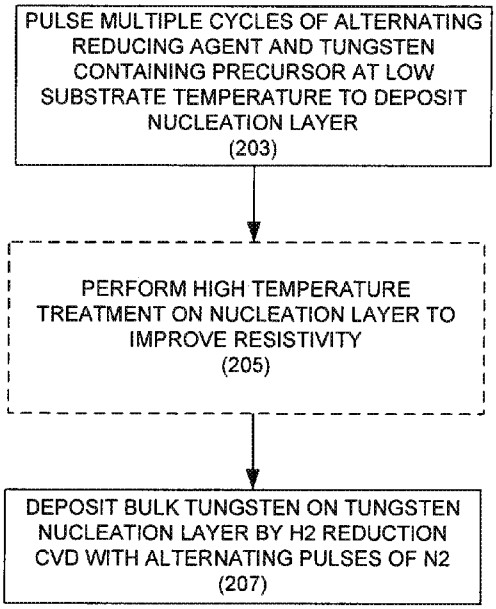


FIGURE 2

(57) Abstract: Methods of producing low resistivity tungsten bulk layers having lower roughness and higher reflectivity are provided. The smooth and highly reflective tungsten layers are easier to photopattern than conventional low resistivity tungsten films. The methods involve CVD deposition of tungsten in the presence of alternating nitrogen gas pulses, such that alternating portions of the film are deposited by CVD in the absence of nitrogen and in the presence of nitrogen. According to various embodiments, between 20-90% of the total film thickness is deposited by CVD in the presence of nitrogen.

WO 2010/025357 A3

WO 2010/025357 A3

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:
3 June 2010