

Dual Layer Negative Tone Metal Lift-off Electron Beam Lithography process for nanometer scale Plasmonic and Photonic devices.

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In this work we investigate a dual layer negative tone resist process for metal lift-off using electron beam lithography employing HSQ as the imaging layer above PMMA. We employ RIE using oxygen to clear exposed areas of the PMMA film, and to generate precision reentrant profiles beneath the HSQ enhancing the metal lift-off patterning result.¹

This process was developed to fabricate slotted waveguides², dipole antennas, and C-shaped apertures for plasmonic devices³ in Au and Ag thin films, but has broad application in hard masking for RIE pattern transfer for integrated Photonic Crystals and waveguide structures, X-ray Zone Plates, direct-write NIL Mold fabrication⁴, and to fabricate micro-fluidic and MEMS device structures.

This process can also be used in Ion Beam Lithography with emerging IBL systems.⁵

A thorough review of HSQ exposure and development processing methods^{6,7} are reported with several improved process enhancements identified.

Excellent control of Line Width and Line Edge Roughness critical dimension and reentrant resist profiles is demonstrated down to 20 nm critical dimension.

1. H. Yang *et al.*, *Microelectronic Engineering* 85, (2008) 814-817
2. G. Veronis, S.Fan, *Opt. Exp.* 16(3) 2008 2129-2140
3. YT Chen *et al.*, *Opt. Exp.* 19(6) 2011 5077-85
4. J. Conway, J. Kruger, M. Mansourpour, P. Rissman, *JVST B* 29(6) 2011 06FC17-1
5. W. Li, W. Wu, R.S. Williams, *JVST B* 30(6) 2012 06F304-1
6. A. Grigorescu, M. Krogt, C. Hagen, P Kruit, *JVST B* 25(6) 2007 1998-2003
7. J. Yang and K. Berggren *JVST B* 25(6) 2007 2025-29

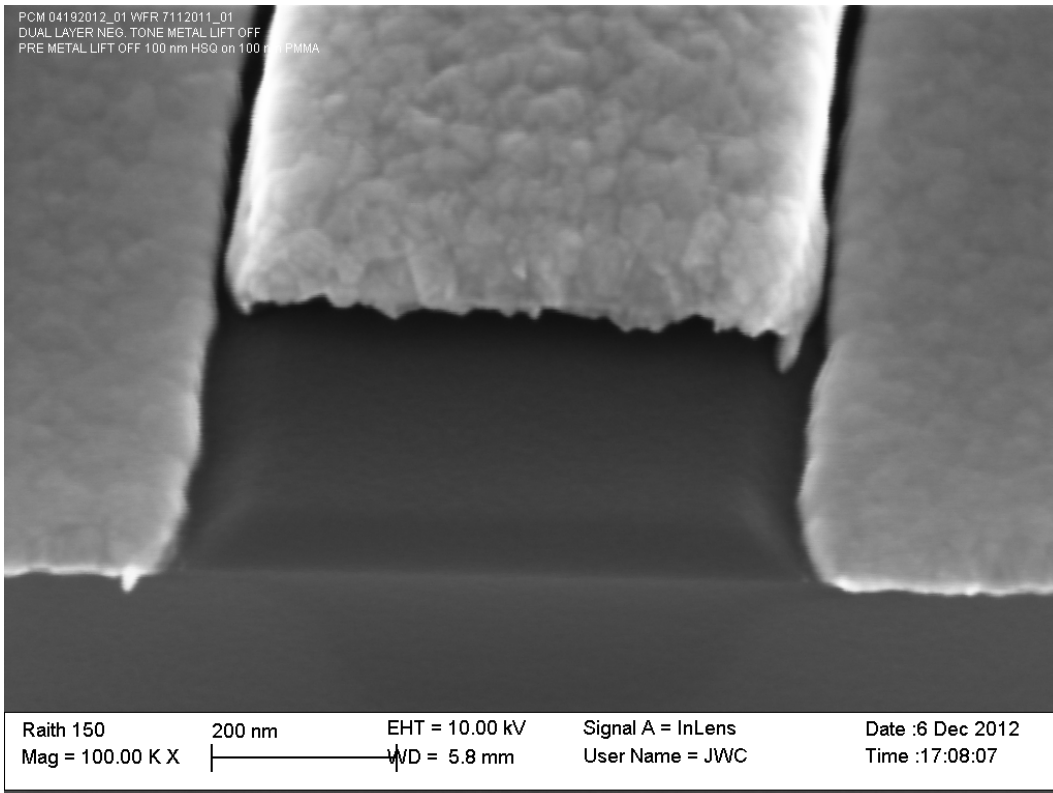


Figure 1: Cross section SEM, pre-metal liftoff, displaying HSQ imaging layer over exposed reentrant PMMA resist profile under 2 nm Ti / 10 nm Au thin film

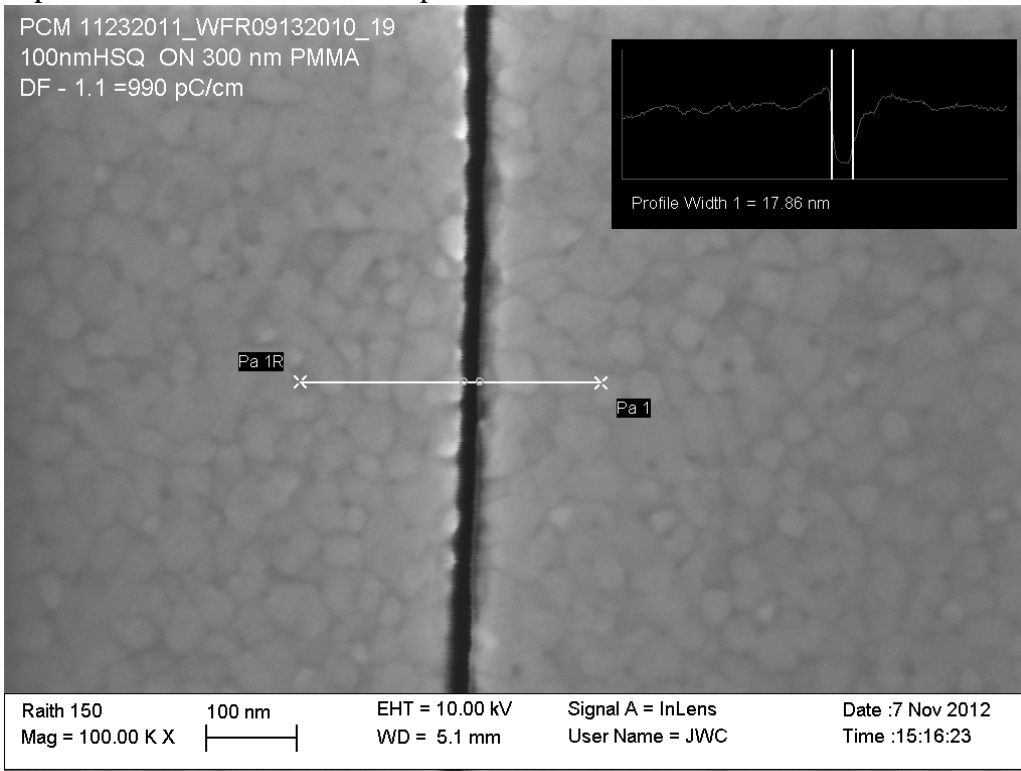


Fig 2: SEM: single pixel line pattern, post metal liftoff, 18 nm slot width in 2 nm Ti / 10 nm Au thin film on silicon