Effects of Mask Material Conductivity on Lateral Undercut Etching in Silicon Nano-Pillar Etching

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Introduction: High aspect ratio silicon structures have gained significant interest due to its vast applications. Minimal lateral etch under the mask is essential to achieve very high aspect ratio silicon nanostructures. Previously, we reported that chromium oxide is better than metallic chromium as a hard mask for silicon etching in terms of etch rate and selectivity to resist during mask structure fabriction1. Here we report that insulating metal oxide etch mask like chromium oxide also provides less lateral etch than conducting metal etch mask using non-switch "pseudo-Bosch" dry etching.

Purpose: The mask structure was fabricated by electron beam lithography and liftoff, with all the metal and metal oxide coated by evaporation. Silicon was etched using a non-switching pseudo-Bosch process (Oxford Instrument Plasmalab100, 10 mTorr, 20 W RF power, 1200 W ICP power, 38 sccm C4F8, 22 sccm SF6, 15 o C, etches Si 390 nm/min)2 . Note that, with etching parameter modification, this non-switching process is also capable of tuning the sidewall taper angle from large positive (cone structure) to large negative (inverse cone structure) etch profile.

Methods: Whereas it was found that metal oxide and metal have similar etching selectivity to silicon, the charge distribution on the mask would be different. We speculate that, for metal mask, the negative charge taking in from the plasma due to fast electron motion would move to the edge of the mask disk due to Coulomb repulsive force, attracting ions to bombard the area below the mask that results in more lateral etching; whereas for insulating mask, the negative charge distribution would be more even across the mask disk area since electrons cannot move in an insulator**.**

Biography:

Ripon has extensive expertise in Semiconductor Device, Nano-materials, MEMS/NEMS Engineering. He has 7+ years nanofabrication experience (mostly in design, simulation and characterization of nano/micro devices) in the clean room. Specialties include MEMS/NEMS, Nano-material and Nanostructure, Device fabrication, Nano-device engineering, Electron beam lithography, Helium Ion lithography and Scanning probe lithography, Semiconductor Device Characterization; Web programming, Finearts.

Publication of speakers:

1. Method of fabricating Nano-scale Structures and nano-scale structures fabricated using the method, Canadian Intellectual Property Office.
2. Two-step potassium hydroxide etching to enhance aspect ratio in trench fabrication, J. Vac. Sci. Technol.
3. Electron beam lithography on the irregular surface using grafted PMMA brush, Advanced Materials Interfaces
4. Theoretical and experimental investigations of nano-Schottky contacts, Journal of Applied Physics

Full name of webinars, dates,

Webinar on Nano materials. March 30, 2021

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