Abstract Submitted
for the GEC14 Meeting of
The American Physical Society

Surface mechanisms during cryogenic etching of silicon with SF_6/O_2 inductively coupled plasmas STEFAN TINCK, University of Antwerp, THOMAS TILLOCHER, Université d'Orleans, ANNEMIE BOGAERTS, University of Antwerp, PLASMANT - GREMI COLLABORATION — A computational and experimental study is performed to obtain better insight in the surface reactions occurring during the etching of silicon with SF_6/O_2 inductively coupled plasmas at cryogenic conditions. Cryogenic etching is a promising technique to etch ultra-high aspect ratio nanoscale trenches for fabricating microchips. During cryoetching, the substrate (i.e., a silicon wafer) is cooled down to about -100 °C. Cryoetching has some advantages compared to the well-known Bosch process, like no scalloping of sidewalls and no material residues on the reactor walls. A disadvantage of cryoetching is its sensitivity to operating conditions such as substrate temperature and fraction of oxygen in the SF_6/O_2 mixture. During etching, the sidewalls of the trenches are passivated with a SiF_xO_y layer which prevents lateral etching. When heating the wafer to room temperature, the passivation layer desorbs automatically, leaving a smooth and clean trench. The mechanism of the formation and desorption of this passivation layer at cryogenic temperatures is not well understood and is investigated here. A 2-dimensional hybrid Monte Carlo Fluid plasma model linked with Molecular Dynamics simulations is used for a computational investigation while results are validated by experimentally measured etch rates. The focus is on the reaction mechanisms during cryoetching in comparison with conventional room temperature etching.

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Date submitted: 04 Jun 2014 Electronic form version 1.4