New etch process developed at the CNST uses argon pulsing to improve silicon etch rate and selectivity

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Engineers in the CNST NanoFab have developed a new plasma etching technique for silicon which improves the etch rate, the mask selectivity, and the sidewall profile by optimizing the addition of argon to the process flow. Small and high aspect ratio silicon structures can now be easily and more rapidly fabricated in the NanoFab using fluorinated plasma chemistry that is inherently isotropic.

Directly adding argon to a typical SF6/C4F8 plasma primarily causes dilution and reduces the etch rate. By alternating the etch step with an argon-only step, both high selectivity and high etch rates were obtained while maintaining anisotropic etching.

In a deep silicon etch, C4F8 is used to protect the Si sidewalls and SF6 is used to etch. Mixing argon with the etchant gases provides very limited or no improvement to the etch rate due to dilution.

However, alternating argon surface bombardment steps with the chemical etch steps results in a four-fold increase in the silicon etch rate while maintaining vertical sidewalls.

The silicon etch rate increases with the argon step time, independent of the SF6 step time, and the argon bombardment step is rate-determining. It influences the etch rate, as well as the selectivity and etching profile.

The engineers postulate that argon surface bombardment renders the top atomic layers of the silicon amorphous, and then gas phase fluorine can react with and remove the silicon. With the long etch times associated with deep silicon trench etching, this faster process is likely to become widely used.

More information: Effect of alternating Ar and SF6/C4F8 gas flow in Si nano-structure plasma etching, L. Chen, et al., Microelectronic Engineering 88, 2470-2473 (2011).

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