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ALE of SiO_2 by alternating CF_4 plasma with energetic Ar^+ plasma beams

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With the development of microelectronics industry, as the technology node is now shrinking to sub 7 nm, atomic layer etching (ALE) increasingly plays an irreplaceable role in realizing higher precision control of etching.

In the research, by coupling a one dimensional fluid/MC model with a trenching model, we simulate the ALE cycle in Ar/CF_4 and Ar capacitively coupled plasmas, in which four steps are involved. The first step is to etch the substrate by using the F atoms and other radicals in the Ar/CF_4 plasma, meanwhile, fluorocarbon (CF_x) film is deposited on the surface; secondly, purging the residual gas; thirdly, utilizing the Ar positive ion to bombard the fluorocarbon (CF_x) layer in the Ar plasma; the last step is also to remove the residual gas. In our simulation, the ion energy is too low to bombard the substrate in the first step so we treat the ions as hot neutral gas in the trenching model. Base on the fluid/MC model, the plasma parameters, for example the particles density as well as the electron and ion energy distributions, can be obtained self-consistently for the simulation of the etching profile in the trenching model.

Our results show that the etching profile can be improved with the etching rate increased, by controlling the ion energy and angle distribution as well as the etching-deposition duty ratio.

Keywords: Atomic layer etching, Alternating gas, Capacitively coupled plasma, Etching profile.

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