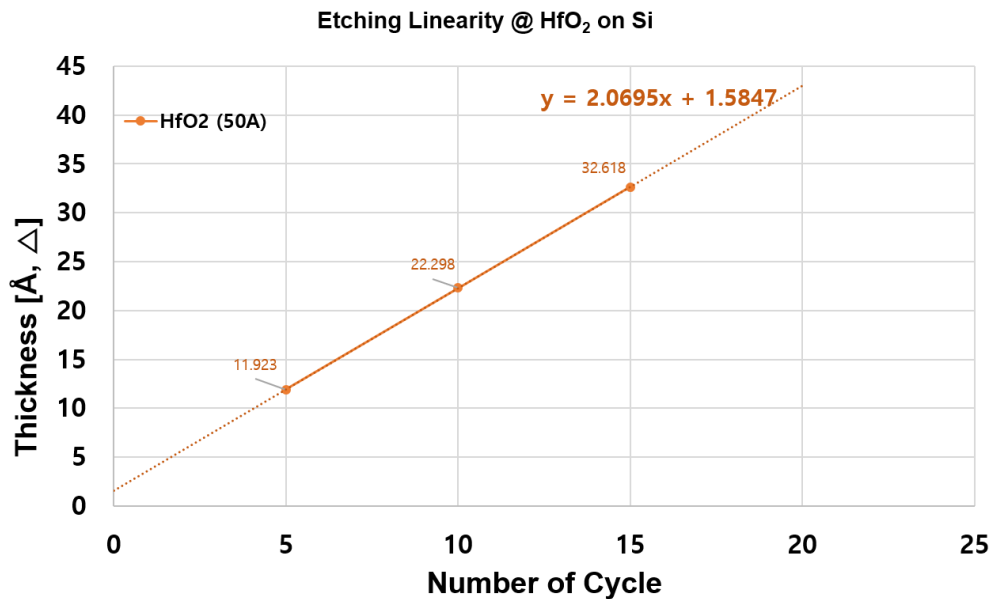


Isotropic Atomic layer etching process for HfO₂ film

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The atomic layer etching (ALE) process is a sub-nanometer scale removal technique based on sequential, self-limiting surface reactions.^{1,2} In this study, we developed a cyclic isotropic plasma ALE process that involves fluorination with NF₃ plasma and ligand exchange with dimethylaluminumchloride (DMAC) for hafnium oxide (HfO₂). The HfO₂ surface is converted to HfOF_x by NF₃ remote plasma in the fluorination step, and the fluorinated layer is removed by a ligand exchange reaction with DMAC in the removal step. The ALE process was analyzed by ellipsometry, atomic force microscopy, dynamic secondary ion mass spectrometry, transmission electron microscopy, x-ray diffraction. Etching was not observed at 200 °C and was increased from 1.41 Å/cycle to 2.22 Å/cycle as the process temperature increased from 250°C to 300°C. Isotropic removal of HfO₂ thin films was observed on the trench patterns with an aspect ratio of >15. In addition, the ALE process decreased the surface roughness of the HfO₂ thin films.



Reference

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