Simulation of Silicon Etch Profiles in High Density Plasmas Using a Level Set Method

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Level Set 방법을 이용한 Si의 고밀도 플라즈마 식각 프로화일 모사

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In recent years, the most significant advancement in dry etching of semiconductor materials has been the utilization of high-density plasmas. As the feature size continues to shrink a more detailed understanding of plasma etching is important for feature transfer. To effectively design the future generation of etching equipments and optimize the etching process, it is necessary to understand the phenomena occurring in trench features. To adequately simulate the feature profile evolution with tracking the moving interface, it is necessary to include plasma sheath dynamics, angular distribution of ions and reemission of neutrals in the trench, and deposition or etch rate. Based on bulk plasma density the sheath dynamics is solved.

In this work, simulation of feature profile evolution in high density plasma etching processes has been carried out using a level set technique. Main feature of this work is inclusion of sheath dynamics, angular distribution of ions and reemmision of neutrals in the trench, etch kinetics, and a level set equation for tracking a moving front of the feature profile. Sheath dynamics showed that the damped potential was somewhat shifted to right and smaller than the applied potential. Etch profile simulations were performed for etching of silicon in inductively coupled plasmas of Cl_2 and CF_4 under various conditions. In dry etching of Si with CF4 discharges, polymer deposition was dominant at $p_{CFx} > 10$ mTorr, while surface fluorination (or ion-enhacned etching) was a main mechanism at $p_{CFx} < 10$ mTorr. The predicted etch profiles showed a slight bowing on side walls and substantial tapering near the bottom, depending on plasma parameters.

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