Atomic scale etching of poly-Si in inductively coupled Ar and He plasmas

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For fabrication of novel Si-based devices, device structures with a high aspect ratio are increasingly required. The reactive ion etching is widely used for defining fine features, but energetic ions generated in a plasma are known to cause serious radiation damages. In a low-energy ion system, isotropic chemical reactions caused by neutrals become predominant and the deterioration of the pattern definition will occur. Therefore, a new concept of directional etching with minimum reaction energy is needed. In this work, atomic scale etching of poly-Si was performed by using a cyclic process of etchant adsorption and ion beam irradiation. This process is the same as the so-called "atomic layer etching" of single crystalline Si. Cl_2 was used as an etchant gas, and Ar or He ions generated in an inductively coupled plasma was used as an ion beam. It was found that there exists a range of bias voltages where the etch rate is nearly constant. This range of bias voltages for He plasmas was wider than that for Ar plasmas.