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Oxygen Ion Beam Induced Abnormal Topographic Development at the Ta/Si Interface Studied by SIMS, XPS, and AFM

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We observed irregular interface artifacts at SIMS depth profiles of Ta/Si by 7 keV O_2^+ ion beam, which was correlated with the abnormal topographic development at the Ta/Si interface. Surface topographic studies by AFM at the crater bottoms after SIMS depth profiling by oxygen ion beams showed extraordinary large topographic development.

AFM clearly showed that two types of surface topography were developed at the Ta/Si interface after sputtering by oxygen ion beam. One is hillock type of 100-150 nm diameter and the other is round crater type of 300-400 nm diameter. The round craters were evolved from the large blisters, of which the center collapsed under oxygen ion bombardment. Point AES analysis showed that a Si surface is exposed at the opened centeral area of the round crater, which indicates the void formation at the Ta/Si interface. However, the small hillocks did not grow with void formation and therefore the shape of the small hillocks did not change upon further sputtering.

The interface artifacts and topographic development found to be closely related to the experimental parameters, such as ion species, ion energy, the angle of incidence. The abnormal topographic development at the interface were not observed by Ar ion beam. XPS depth profiling of Ta/Si by oxygen ion beam showed that Ta oxide layer was grown near the interface. It is suggested that the hillock and crater formation is due to the compressive stress ascribed to the volume increase by Ta oxidation enhanced at the interface. The mechanism of the enhanced oxide layer formation near the interface and hillock formation will be discussed in detail.