The Interaction of Water with Ultrathin Silica Films Grown on Mo(112)

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Abstract

The adsorption of water on ultra-thin SiO2 films at low temperatures has been studied with metastable impact electron spectroscopy (MIES) and ultraviolet photoelectron spectroscopy (UPS (HeI)). High-resolution electron energy-loss spectroscopy (HREELS), work function measurements (Saudi Arabia), and temperature-programmed desorption (TPD) were also utilized to study the interaction of water with silica. Evidence for molecular adsorption of water on low- and high-defect silica surfaces is presented. The data are consistent with the growth of 3-D water clusters even at low coverage; i.e., the water-water hydrogen bonding is stronger than the water-silica interaction. No evidence for dissociation of water was found in contrast to previous UPS results.

Conclusions

- Water adsorbs molecularly on SiO2 thin films prepared on Mo(112). Considering the lower limit of the detectability of hydrogen-bonding by MIES and UPS, we estimate that the fraction of dissociated water molecules is at most 9%.
- However, since there is no evidence for water dissociation, it is likely that water does not react with SiO2 thin films prepared under UHV conditions and annealed at elevated temperatures.
- Extended defects, i.e., steps and corners, are not sufficient to cause water dissociation on SiO2 thin films prepared on Mo(112). The results indicate that clustering of water, i.e., 3-D growth, begins at very low coverages. The water-water interaction via hydrogen bonding is stronger than the interaction of water with the silica thin film.
- That no water dissociation takes place is possibly related to a very low density of point defects.
- Varying peak positions of the 3a1 orbital in MIES and UPS (HeI) for multilayers of water above 1 ML can be explained involving different surface sensitivities of MIES and UPS (HeI).

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