Scanning Tunneling Microscopy and Adsorption Studies on Single-Crystal Metal Oxide Surfaces

by

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Thesis submitted to the faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Chemical Engineering

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September, 1997
Blacksburg, Virginia

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(ABSTRACT)

Natural and synthetic SnO_2 samples were studied using scanning tunneling microscopy (STM). The SnO_2 surface flattens considerably, with large unevenly distributed circular features forming following high temperature treatments of up to 1500 K. The conductivity of the synthetic SnO_2 surface is significantly reduced following annealing at temperatures of approximately 1200-1500 K, making tunneling impossible. A decrease in conductivity was not observed for the natural SnO_2 sample following similar high temperature treatments, most likely due to impurities which act as dopants. No atomic-scale images were collected on the SnO_2 surfaces which provided information regarding atomic positions and point defects on the surface.

Water adsorption was studied on the stoichiometric Cr_2O_3 (10$\underline{1}$2) surface, using thermal desorption spectroscopy (TDS). Water is the only desorption product observed during TDS. Adsorption is primarily dissociative following exposure to water at 163 K. Approximately, 0.12 monolayers of water dissociate on a clean, nearly stoichiometric Cr_2O_3 (10$\underline{1}$2) surface. The first-order kinetics observed for the recombination of dissociated water are not well understood. One possible explanation is that the rate limiting step for desorption involves the breaking of a Cr-O bond resulting in a freely diffusing OH species.

The exchange of halogen and oxygen was studied on Cr_2O_3 (10$\underline{1}$2) using Auger electron spectroscopy (AES) and TDS. The exchange of chlorine and oxygen is completely reversible. Chlorine is removed from the Cr_2O_3 (10$\underline{1}$2) surface following exposure to oxygen. Exposure of $CFCl_2CH_2Cl$ reduces the surface oxygen concentration to that of the clean, nearly stoichiometric Cr_2O_3 (10$\underline{1}$2) surface. The exchange of chlorine with oxygen appears to involve only chemisorbed surface oxygen, not bulk lattice oxygen.