RADIATION INDUCED CHEMICAL ACTIVITY AT IRON AND COPPER OXIDE SURFACES

Abstract

by

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The radiolysis of three iron oxides, two copper oxides, and aluminum oxide with varying amounts of water were performed using γ-rays and 5 MeV ^{4}He ions. The adsorbed water on the surfaces was characterized using temperature programmed desorption and diffuse reflectance infrared spectroscopy, which indicated that all of the oxides had chemisorbed water on the surface. Physisorbed water was observed on the Fe_2O_3 and Al_2O_3 surfaces as well. Molecular hydrogen was produced from adsorbed water only on Fe_2O_3 and Al_2O_3, while the other compounds did not show any hydrogen production due to the low amounts of water on the surfaces. Slurries of varying amounts of water were also examined for hydrogen production, and they showed yields that were greater than the yield for bulk water. However, the yields of hydrogen from the copper compounds were much lower than those of the iron suggesting that the copper oxides are relatively inert to radiation induced damage to nearby water.

X-ray diffraction measurements did not show any indication of changes to the bulk crystal structure due to radiolysis for any of the oxides. The surfaces of the oxides were analyzed using Raman spectroscopy and X-ray photoelectron spectroscopy (XPS). For the iron samples, FeO and Fe_3O_4, Raman spectroscopy revealed areas of Fe_2O_3 had formed following irradiation

with He ions. XPS indicated the formation of a new oxygen species on the iron oxide surfaces. Raman spectroscopy of the copper oxides did not reveal any changes in the surface composition, however, XPS measurements showed a decrease in the amount of OH groups on the surface of Cu_2O, while for the CuO samples the amount of OH groups were found to increase following radiolysis. Pristine Al_2O_3 showed the presence of a surface oxyhydroxide layer which was observed to decrease following radiolysis, consistent with the formation of molecular hydrogen.