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Project Title: Radiolytic and Thermal Processes Relevant to Dry Storage of Spent Nuclear Fuels

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FINAL PROGRESS REPORT - Rutgers accomplishments

RESEARCH OBJECTIVE

The focus of our experimental research activities at Rutgers University was to characterize the effects of temperature and radiation processes on the interactions of H_2O with oxide surfaces. Our experiments focused on the fundamental interaction of H_2O molecules with surfaces of UO_2. We characterized the surface chemistry of adsorbed H_2O using thermal desorption methods and radiotracer methods, as well as x-ray photoelectron spectroscopy (XPS) and low energy ion scattering (LEIS). In parallel with these measurements of thermal effects, we examined the effects of secondary electrons and high-energy photons on hydrogen

and oxygen generation and, and how this related to corrosion of spent nuclear fuel. These studies concentrated on neutral and ionic (cation and anion) desorption products of low-energy electron irradiation of water-covered UO_2.

RESEARCH PROGRESS

As of the end of this award, we made substantial progress in several areas. (a) We have carried out studies of the $UO_2(001)$ single crystal surface using x-ray photoelectron spectroscopy (XPS), low energy electron diffraction (LEED), and electron stimulated desorption (ESD). We developed a surface cleaning procedure, characterized the surface stoichiometry and structure, and measured the interactions of this surface with water vapor. (b) We have characterized the thermal stability and stoichiometry of polycrystalline UO_2 films by means of x-ray photoelectron spectroscopy (XPS), as well as high resolution electron microscopy and Rutherford Backscattering (collaboration with Prof. Jory Yarmoff, UC Riverside). (c) We have made thermal desorption measurements and electron stimulated desorption measurements of H_2O from polycrystalline uranium dioxide film surfaces. (d) We have used tritiated water and a radiotracer technique in the first experiments to measure water desorption kinetics from surfaces of UO_2 films and of polycrystalline ZrO_2, under atmospheric conditions (collaboration with Austrian researchers, group of Prof R. Dobrozemsky, Vienna).

Publications:

"Interaction of Water Vapor with $UO_2(001)$", M.N. Hedhili, B. V. Yakshinskiy and T.E. Madey, Surf. Sci. 445, 512-525 (2000) – see attachment

"Characterization of uranium oxide thin films grown from solution onto Fe surfaces", S. R. Qiu, C. Amrhein, M. L. Hunt, R. Pfeffer, B. Yakshinskiy, L. Zhang, T. E. Madey, and J. A. Yarmoff, Appl. Surf. Sci. 181, 211-224 (2001) – see attachment

"Reaction of atmospheric humidity with thin uranium oxide films", N. Hedhili, R. Dobrozemsky, K. Buchtela, J. Yarmoff, and T. E. Madey, in preparation.

"Interaction of Water Vapor with Uranium Oxide Films", B. V. Yakshinskiy, M. N. Hedhili, and T. E. Madey, in preparation.

Presentations:

"Interaction of Water Vapor with $UO_2(001)$" American Physical Society, Atlanta, 3/99

"Interaction of Water Vapor with $UO_2(001)$" American Chemical Society, New Orleans, 8/99