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Author: P. Petrik A. Sulyok T. Novotny E. Perez-Feró B. Kalas E. Agocs T. Lohner D. Lehninger L. Khomenkova R. Nagy J. Heitmann M. Menyhard Z. Hózer



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Optical properties of Zr and ZrO₂

P. Petrik^a, A. Sulyok^a, T. Novotny^a, E. Perez-Feró^a, B. Kalas^{a,b}, E. Agocs^a,
T. Lohner^a, D. Lehninger^c, L. Khomenkova^d, R. Nagy^a, J. Heitmann^c,
M. Menyhard^a, Z. Hózer^a

^aCentre for Energy Research, Hungarian Academy of Sciences, Konkoly Thege Rd.
29-33, 1121 Budapest, Hungary

^bDoctoral School of Physics, Faculty of Science, University of Pécs, Ifjúság útja 6,
H-7624 Pécs, Hungary

^cInstitute of Applied Physics, TU Bergakademie Freiberg, D-09596 Freiberg, Germany

^dV. Lashkaryov Institute of Semiconductor Physics, 45 Pr. Nauky, Kyiv 03028, Ukraine

Abstract

Optical properties of Zr and its oxide have been measured on the surface of nuclear fuel cladding tubes. It has been shown that ellipsometry with focusing can routinely be used to measure thin layers and surface properties on Zr tubes with a diameter as small as 9.1 mm. Multi-sample and depth profiling models have been used to determine reference dielectric function spectra for both the Zr substrate and its oxide. Temporal behavior of the oxide thickness has been measured for oxidation temperatures of 600 °C and 800 °C. A vertical inhomogeneity of the oxide properties has been found by the optical measurements as well as by depth-profiling X-ray photoelectron spectroscopy investigations that revealed the formation of sub-oxides at the interface region of Zr and its surface oxide.

Keywords:

Zirconium, Zirconium oxide, Oxidation, Nuclear fuel cladding, Spectroscopic ellipsometry, X-ray photoelectron spectroscopy, Dielectric function,

1. Introduction

Zirconium and its oxide have been applied in a broad range of fields [1, 2]. Zr tubes for example are used as a cladding for nuclear fuel [1]. Understanding its oxidation during the operation of nuclear reactors is a major safety issue. The corrosion of Zr alloys can result in the formation of

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