

Electrochemical passivity of N18 Zircaloy before and after kinetic transition

Yunhan Ling¹, Junji Gu¹, Wenjun Zhao², Yixiong Shen¹, Xinde Bai¹,

¹Laboratory of Advanced Materials, Department of Materials Science and Engineering, Tsinghua University, 100084, Beijing China

²National Key Laboratory for Nuclear Fuel and Materials, Nuclear Power Institute of China, 610041, Chengdu China

As a major fuel cladding material, zirconium alloys will experience different corrosion stages in pressurized water reactors (PWR) and boiling water reactors (BWR); it typically follows a growth rate from cubic, parabolic to linear which defined as pre- and post-transition from the weight gain curves. The corrosion mechanism behind the transition, however, is far from well understood. The motivation of this work is to acquire more insight from the viewpoint of passivity evolution on N18 Zircaloy, a new developed Zr - Sn - Nb series alloy in China, through impedance analysis and potentiostatic polarization of the specimens with a history of being vapor oxidized under 400 °C and 10.3 MPa. Two time constants were found in the electrochemical impedance spectroscopy (Fig.1), indicating double layer structures, the external hydrolysis precipitation and inner passive films, existed before and after transition; fluctuation changes in current at a fixed polarization bias (Fig.2) imply that ever-accumulating structural defects should be underwent beneath the film with corrosion duration; typical local (pitting) corrosion feature (Fig.3) and microstructure analysis provide further proofs for this hypothesis.

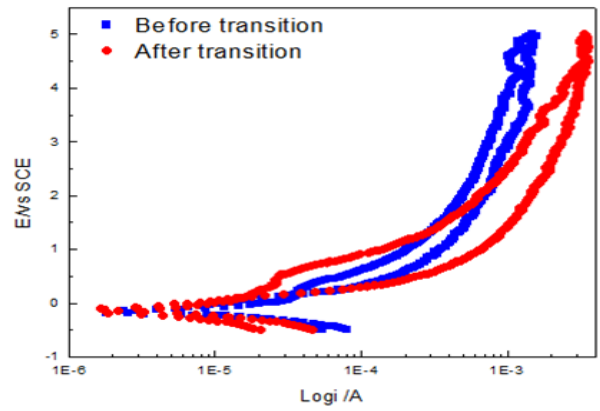


Fig.3 Cyclic polarization of N18 Zircaloy before and after kinetic transition

The work was supported by Major State Basic Research Development Program of China (2011CB610501).

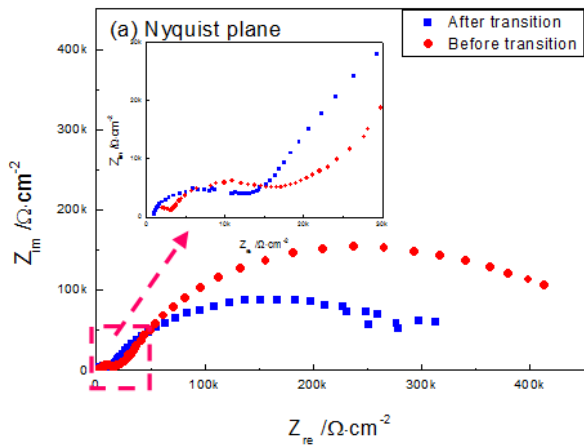


Fig.1 Electrochemical impedance spectroscopy of N18 Zircaloy before and after kinetic transition

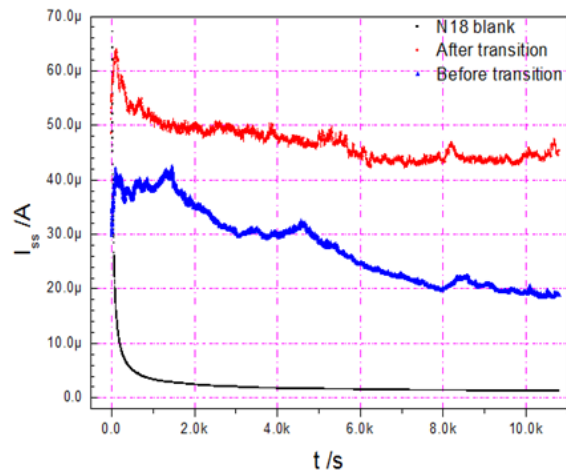


Fig.2 Potentiostatic transients for N18 Zircaloy upon anodic polarization