

## **Impact of Zirconium Hydride precipitates on Fracture of a Zirconium alloy**

M. Kerr, M.R. Daymond, and R.A. Holt - Department of Mechanical and Materials Engineering, Queen's University

J.D. Almer - Advanced Photon Source, Argonne National Laboratory

**Abstract** Zirconium alloys are of major importance to the nuclear industry, with primary application as a structural material for the in-reactor environment. The formation of brittle hydrides in zirconium alloys results in a degradation of the mechanical properties of the component in which they form. Thus, the rate and characteristics of formation and the subsequent impact of these hydrides are critical factors in the determination of zirconium component service life. This is a three part study of hydrides in zirconium using high energy synchrotron x-ray diffraction. Part I characterized the mechanical response of zirconium hydride, *in situ* in a Zircaloy-2 matrix. This study provided quantitative data on the elastic response of the hydride, as well as load transfer and fracture of the hydride phase; confirmed with finite element and composite mechanics models. Part II studied the near crack tip behavior of unhydrided Zircaloy-2. Strain field evolution as a function of applied load as well as the initiation of crack tip twinning were characterized with 2D mapping techniques. Two material orientations relative to the parent texture were investigated in a fatigue pre-cracked condition with the results compared to finite element models. Part III then build on the results of the mapping study to characterize the effects of hydrides in the vicinity of the crack tip. The aim is to quantify the influence of crack tip hydrides on the local strain field around the crack tip, and to characterize the internal strains in the crack tip hydrides themselves.