ICSMA19 Metz, France, June 26 - July 1, 2022
International Conference on Strength of Materials

Quantifying the Recovery of Cold-Worked Zr-2.5Nb using X-ray Diffraction Line Profile Analysis

Thalles T. A. Lucas[a], Fei Long[a], Aaron Barry[b], Mark R. Daymond[a], Donald W. Brown[c], L. Balogh[a]

[a]*Queen's University, Kingston ON, Canada*

[b]*Royal Military College of Canada, Kingston, ON, Canada*

[c]*Los Alamos National Laboratory, Los Alamos, NM, USA*

[a]*levente.balogh@queensu.ca*

The recovery kinetics of dislocation structures formed by either cold-work or irradiation are expected to be different due to the dissimilar configuration of lattice dislocations and dislocation loops. Unirradiated Zr-2.5Nb pressure tube material was plastically deformed at 250 deg C to introduce a high density of cold-work dislocations at the same temperature at which dislocation loops form in the material while in service in nuclear reactors. Samples of the cold-worked Zr-2.5Nb were annealed isothermally for various lengths of time at multiple temperatures and were measured using high resolution synchrotron X-ray diffraction. The diffraction patterns were evaluated by Diffraction Line Profile Analysis (DLPA) using the Convolutional Multiple Whole Profile (CMWP) method to quantitatively characterize the dislocation density and character as a function of annealing time and temperature. Using this information, the activation energy and the pre-exponential factor of the recovery process was obtained for cold-work dislocations. The results will be compared to the recovery kinetics obtained for irradiated Zr-2.5Nb using neutron diffraction and the differences will be discussed.

Keywords: X-ray diffraction, line profile analysis, dislocations, recovery, zirconium, cold work.