

Defect Measurement Methods

All in situ dynamic TEM observations of damage evolution were performed at a 300 keV operating voltage which is below the threshold voltage (328 keV) for electron knock-on damage in Zr. Irradiation was paused at different dose levels to characterize the damage microstructure using weak beam dark field (WBDF), kinematical bright-field (KBF) and dynamical two-beam diffraction conditions. During in situ TEM analysis, care was taken to maintain consistent imaging conditions so that proper comparisons could be made of damage structures from one area at different dose levels to another area or from one specimen to another at similar dose levels. It is worthwhile to mention that the term “defect” has been used to describe resolvable irradiation induced dislocation loops. Number density and image size measurements of defects were made from WBDF micrographs. In counting defects it was sometimes difficult to distinguish very small irradiation-induced defects from surface features. These types of features present in damage microstructures were counted as a “half-defect” to overcome the ambiguity. The error bars in number density were determined by the number of such loops as a proportion to the total. Ex situ characterization of irradiated microstructure was performed in OSIRIS electron microscope at an operating voltage of 200 keV.