High energy x-ray diffraction was performed during room temperature tensile loading of irradiated HT9 samples to study tensile deformation behavior in the material. Samples were extracted from several positions along the ACO-3 duct following its irradiation in the Fast Flux Test Facility (FFTF). The samples experienced fast spectrum neutron radiation doses ranging from 2 to 147 dpa at temperatures from 382 to 504°C, depending upon their location within the FFTF reactor core. Diffraction measurements were conducted continuously while slowly deforming the sample at constant strain rate; samples were deformed to approximately 3-8% plastic strain. Analysis of the shift in diffraction peak position during deformation allows for determination of elastic lattice strains in two primary constituent phases of the material: the $\text{M}_2\text{C}_6$ carbide particles and the ferrite matrix. All of the samples exhibited a clear load transfer between phases: when the yield stress was reached and the ferrite matrix began deforming plastically, the small volume fraction of carbides in the material accommodated further increases in the applied load by accumulating substantially more lattice strain.

The dislocation density evolution in the material as a result of deformation was characterized through full pattern line profile analysis. There were substantial increases in the dislocation densities after deformation; the level of dislocation evolution observed was highly dependent upon the irradiation temperature of the sample. Differences in both the yield and hardening behavior between samples irradiated at higher and lower temperatures suggest the existence of a transition temperature near 410°C dividing regions of different dominant damage effects. At the high irradiation doses examined in this work, deformation behavior was dominated by the effect of irradiation temperature over that of the dose.