USAXS/SAXS/WAXS as a Powerful In-Situ Approach to Understand Helium Bubble Kinetics in Metals; from Crystal Defects to Meso-Scale Bubble Growth

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Design and maintenance of materials exposed to alpha-radiation depends heavily on our understanding of the state of He atoms in the exposed metal. Based on the current literature, implanted He can be found at the lattice level (defects) or in nanoscale heterogeneities (bubbles). In this study, He atoms were implanted into Al and Sn at Lawrence Livermore National Laboratory. X-ray scattering techniques were used to resolve the bubble size and lattice strain as a function of He concentration, metal temperature (and state), and He implantation energy. The experimental setup and approach is presented here along with key results from both lab-based and synchrotron experiments that are able to resolve strain, as well as bubbles on the nanometer length-scales in the solid state and meso-scale bubbles in the melted state.