EFFECT OF MICROSTRUCTURE ON THE INTERNAL HYDRIDING BEHAVIOR OF URANIUM

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Literature establishes that bulk uranium hydride (UH_3) formation degrades the mechanical performance of uranium and can be influenced by changes in microstructure. Yet, mechanistic understanding of how microstructural variations affect bulk UH_3 characteristics remains limited due to the challenges associated with characterizing UH_3-containing uranium via traditional microscopy-based methods (*e.g.,* the rapid and destructive oxidation of air-exposed UH_3 particles). To address this knowledge gap, the internal hydriding behavior of coarse grain (1 mm) cast and fine grain (0.025 mm) rolled uranium containing hydrogen concentrations between 0 and 1.8 wppm were evaluated via small angle neutron scattering (SANS). Increasing hydrogen content up to 1.8 wppm in the coarse-grained, cast uranium only weakly affected the average UH_3 precipitate size, calculated from the SANS data. Conversely, the UH_3 phase fraction was found to strongly depend on the hydrogen content in the same as-cast samples. Interestingly, a substantially reduced UH_3 particle size distribution was observed in the fine-grained, rolled uranium relative to cast uranium containing the same nominal hydrogen content. It is hypothesized that the suppression of UH_3 formation in the rolled uranium is driven by increased hydrogen trapping at grain boundaries, and theoretical calculations that account for trap density, potency, and hydrogen diffusion kinetics support this hypothesis.

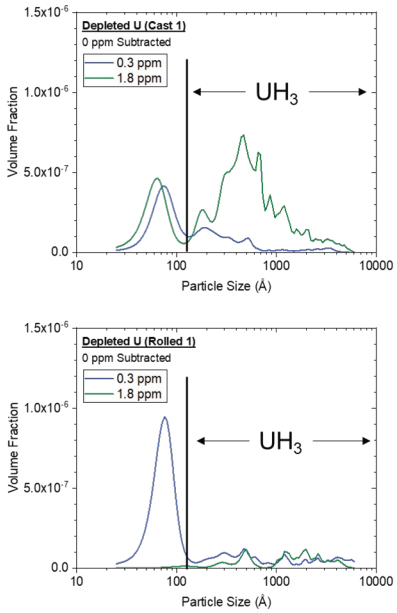

Figure 1 - UH_3 size distributions for the (top) coarse-grained Cast 1 and (bottom) fine-grained Rolled 1 uranium materials heats charged with 0.3 and 1.8 wppm hydrogen.