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Zr alloys such as Optimized ZIRLO are widely used for cladding in fission nuclear applications [1]. Understanding the local segregation of elements via atom probe tomography (APT) provides critical feedback regarding both failure and strengthening mechanisms [2]. The traditional sample preparation procedure for atom APT of Zr alloys includes focused ion beam (FIB) annular milling to remove oxides that form during electropolishing, as these oxides lead to low yield in APT experiments. However, FIB induces the formation of hydrides when not performed under cryogenic conditions [3], potentially confounding analyses and mechanistic interpretation. Here, we use the new Cameca Invizo 6000 atom probe, which operates using a dual-beam deep-UV laser system, to study Optimized ZIRLO. Using the Invizo system we have observed an improved yield of conventionally electropolished Zr alloys, compared to our local electrode atom probes. Combined with scanning transmission electron microscopy (STEM) of FIB lift-out samples, we study the elemental distribution around β-Nb precipitates and grain boundaries. The β-Nb precipitate was seen to be coated in a continuous near-monolayer of Fe (Fig. 1 and Fig. 2). Additionally, APT results show that Fe, Nb and Sn are enriched at grain boundaries (Fig. 3). As β-Nb plays an important role in enhancing the corrosion resistance of Zr alloys [4], this discovery will help further optimize the design of Optimized ZIRLO.

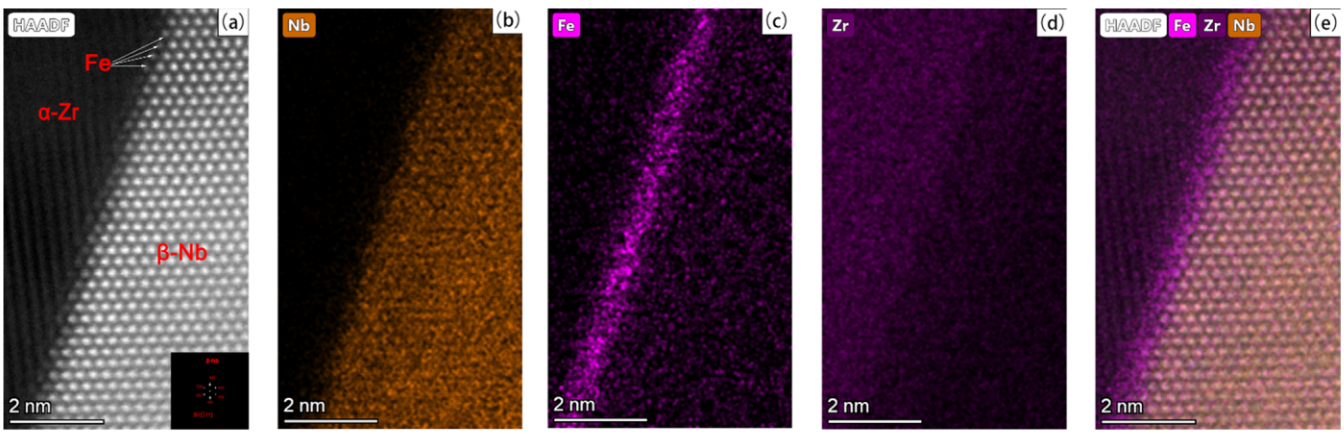

Fig. 1. Characterization of the interface between the α-Zr and β-Nb. (a) HADDF, (b-d) EDS maps of Nb, Fe, Zr individually, and (e) overlay of a-d.

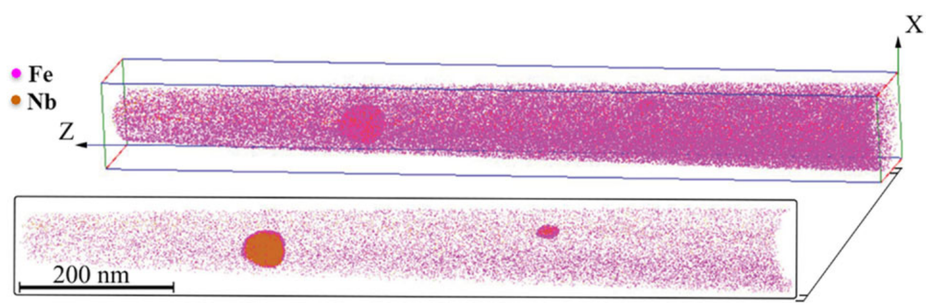

Fig. 2. Reconstructed Invizo 6000 data of Optimized ZIRLO, showing two β-Nb precipitates.

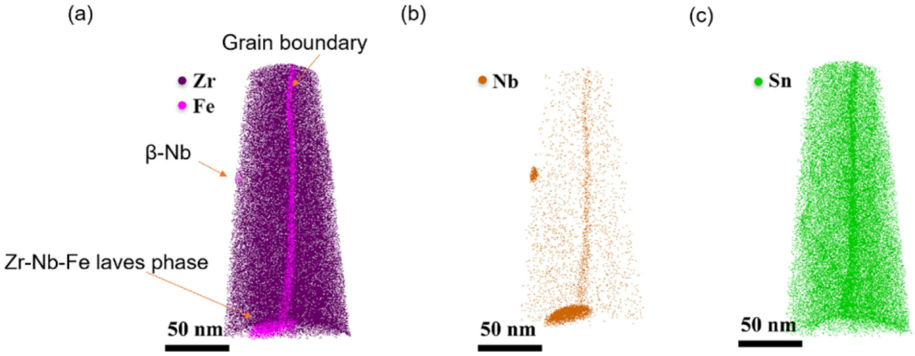

Fig. 3. Reconstructed LEAP 4000 data of Elements distribution at grain boundary and precipitates, a: Zr & Fe, b: Nb, c: Sn.

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