EXPERIMENTAL AND NUMERICAL INVESTIGATIONS OF NANOINDENTATION PROPERTIES AT THE SUB-GRAIN LEVEL IN NI-BASED AND TI-BASED POLYCRYSTALLINE ALLOYS

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Structural metallic/intermetallic materials operating at high temperatures (650°C-1200°C) in severe environments are commonly subjected to in-service surface reactivity, i.e. oxidation, corrosion. These materials are thus affected due to the concomitant effects of surface reactivity, microstructure evolution and deformation. Despite the negligible scale of the physical, chemical, metallurgical gradients in comparison with the dimensions of the structural components, the variability in mechanical behaviour within the gradient often drives premature damage and the progressive rupture of the component [1-2]. A better understanding of the thermo-mechano-chemical elementary mechanisms responsible of early damage at the microscale is needed. Therefore, the present study intends to assess the local mechanical behaviour of polycrystalline Ti- and Ni-based materials affected or not by the oxidation using nano-indentation techniques. Both materials exhibit an anisotropic elastoplastic response (see Figure 1 for the Ni-based materials) and the identification of the local mechanical response is essential to understand deformation processes in the oxidation affected region to dissociate both the effect of the grain orientation and the evolution of the local chemical composition and metallurgical state. Slip trace analyses were also performed to identify active slip systems depending on the orientation of the Berkovich tip as a function of the grain orientation using combination of electron backscattered diffraction, scanning electron microscopy and atomic force microscopy.

Numerical simulations using strain-gradient crystal plasticity finite element modeling were thus conducted to study the effect of crystal orientation, the local chemical concentration and precipitation on the elastic response and the slip activity during nanoindentation of Ti-based and Ni-based materials.

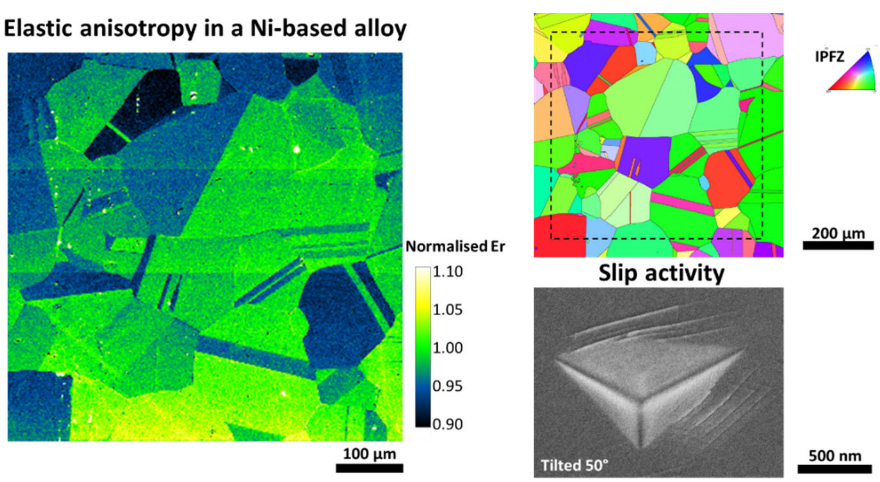

Figure 1 – Map of the reduced modulus for a polycrystalline Ni-based alloy. EBSD map of the region of interest and example of slip activity around the indent

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