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Multi-modal analyses 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. 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 better assess the local mechanical behaviour at the sub-grain level using nano-indentation techniques in Ti- and Ni-based materials affected or not by the oxidation. 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 better understand deformation processes in the oxidation affected region. Numerical simulations using crystal plasticity finite element methods were conducted to study the effect of crystal orientation, chemical concentration and precipitation on the elastic response and the slip activity during nanoindentation of Ti-based and Ni-based materials.

Keywords: Superalloys, Titanium alloy, Nanoindentation, Electron Backscattered Diffraction (EBSD)

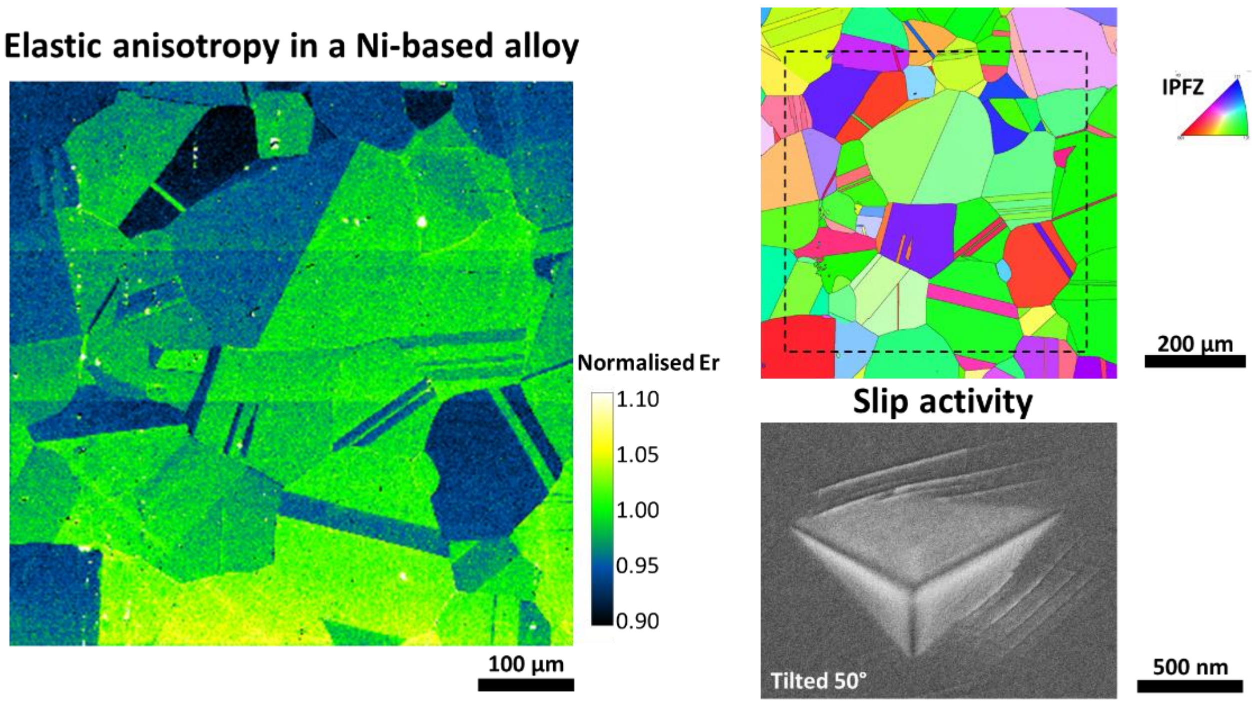

Fig.1: Map of the reduced modulus for different orientation of a Ni-based alloy. EBSD map of the region of interest and example of slip activity around the indent