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Taking a new look at rafting in single crystal superalloys: Exploring the influence of different stress states and the transition towards topological inversion

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Rafting is the directional coarsening of small cuboidal γ'-phase particles during [001] tensile creep testing perpendicular to the direction of the applied stress [1]. Rafting occurs in Ni-base superalloy single crystals with a negative misfit between the two coherent phases γ and γ'. In the present work we take a new look at the phenomenon of rafting. We present some recent results on the influence of different stress states, comparing crept microstructures after uniaxial creep, shear creep and after creep of circular notched specimens. We also consider the effect of internal stresses of microstructural origin on rafting. We interpret our findings on the basis of the underlying elementary deformation and coarsening mechanisms, which govern the evolution of γ/γ'-microstructures. Creep testing in the high temperature low stress creep regime is combined with analytical scanning and transmission electron microscopy. Special emphasis will be placed on the microstructural transition from a rafted to a topologically inversed microstructure. The term topological inversion has been coined to describe a microstructural change, where the initial microstructure in which small γ'-cubes are separated by thin interconnected γ-channels evolves towards a material state where the γ-phase forms isolated islands and the γ'-phase percolates throughout the system [2].

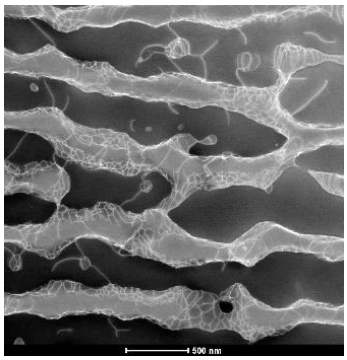

Fig. 1: DF-STEM image of rafted ERBO1 superalloy microstructure after uniaxial creep exposure at 1223 K, 300 MPa and 4% accumulated strain. γ and γ′ phases shown in bright and dark contrast, respectively.

Keywords: Single crystal Ni-base superalloys, high temperature uni- and multiaxial low stress creep, scanning and transmission electron microscopy, rafting, topological inversion.

References:

[1] L. Agudo Jácome et al., High-temperature and low-stress creep anisotropy of single-crystal superalloys, Acta Mater., 61, 2013, 2926-2943.
[2] A. Epishin et al., Kinetics of the topological inversion of the γ/γ′-microstructure during creep of a nickel-based superalloy, Acta Mater., 49, 2001, 4017-4023.