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Deformation response of solid solution strengthened alloy 617 with non uniform grain boundary carbide distribution

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Microstructural changes in grain boundary carbide precipitates have been correlated with stress during creep of solid solution strengthened by nickel based superalloy, alloy 617, at 950°C. The observed redistribution of carbides and carbide migration is explained in terms of dissolution of carbides under compressive stress and coarsening along boundaries subjected to tensile stress. The role of carbide, size, volume fraction and distribution on the deformation response has been examined on 3 microstructure variants of alloy 617 subjected to low cycle fatigue testing under strain controlled loading conditions at 760°C. The 3 microstructures are (1) as-rolled microstructure with uniform distribution of discrete carbide precipitates along all grain boundaries in addition to the presence of carbides in the matrix, (2) solution treated microstructure (1200°C for 2 hours and water quenched) with no carbides in the matrix or along grain boundaries, and (3) solution treated microstructure (1200°C for 2 hours and water quenched) subjected to creep testing at 950°C. This sequence results in redistribution of carbides, localized along boundaries perpendicular to creep load direction which are subjected to tensile stresses. Hysteresis loops associated with complex low cycle fatigue testing were used to determine the isotropic hardening, in terms of yield strength and cyclic hardening/softening, as well as, the kinematic hardening (long- and short-range) as a function of grain boundary carbide size and volume fraction. Results of this analysis are incorporated in a non-linear kinematic, internal state variable model to simulate the cyclic stress-strain response of alloy 617 as a function of the microstructure state with respect to the carbide distribution.

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Biomimetics: Soil fauna inspires new developments on agricultural tools

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Recently, biomimetics has opened a fruitful field of investigation for engineering solutions. It is known that the phenomenon of adherence of soil to solid surfaces of the components of agricultural machinery increases the required drawing force as well as energy consumption of machinery, decreasing the quality of work. To overcome the adhesion of soil to solid surfaces of the components of agricultural machinery, scientists propose to apply biomimetic principles and characteristics of soil fauna for designing such surfaces. The animals that inhabit the soil move without the soil sticking to them, because of their geometric shapes, hydrophobicity, micro-electro-osmotic systems, lubrication and flexibility of the cuticle surface. The physicochemical, mechanical and geometric features of those species can be used for the design of materials and structures of agricultural tools. The present research work addresses this problem by modifying the surface topography of the body involved in an agricultural tool based on the micro-topography of the cuticle of the *Diloboderus abderus* beetle (female), as well as discussing new topographic patterns based on the self-cleaning cuticle of springtails (Collembola). The macro and micro surface topography proposed for the tool is effective to decrease the adherence of soil to the surface of the agricultural tools with a noticeable and significant reduction in the traction force and an increased capacity of penetration of the tool, due to replacement of soil-soil friction with soil-metal friction. This has a deep ecological and economic impact resulting from saving fuel and labor time.

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