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Effect of chemical composition on yield strength in single crystal Ni-based superalloys at low temperature

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The yield strength (YS) of single crystal superalloys is a critical factor for low temperature low cycle fatigue (LCF) and thermomechanical fatigue (TMF) durability of turbine blades [1]. The chemical composition of this class of alloy appears to have a major role in their low temperature tensile behavior [1,2]. Indeed, alloying elements modify the antiphase boundary (APB) energy of the γ' phase [3] and so its resistance to shearing. 18 superalloys with various chemical compositions were tensile tested at 650°C/5.0 x 10^{-4} s^{-1} to better understand how the YS may be influenced by the composition. The tensile results show significant YS differences between first-generation alloys and more advanced alloys, up to 250 MPa (Fig.1). Some alloys with different compositions also exhibit an important strain hardening. The YS differences are mainly attributed to the γ' strengthening which is related to the γ' phase composition. Ta, Ti, Nb and W appear to be potent γ' strengtheners. The higher their content is, the higher the APB energy is and the stronger the alloy is. Thermocalc data were used to estimate APB energies of tested alloys. The strain hardening observed on some alloys remains to be explained and will need further investigations using TEM observations.

Keywords: Superalloy, Single Crystal, Yielding, Gamma Prime Phase, Antiphase Boundary

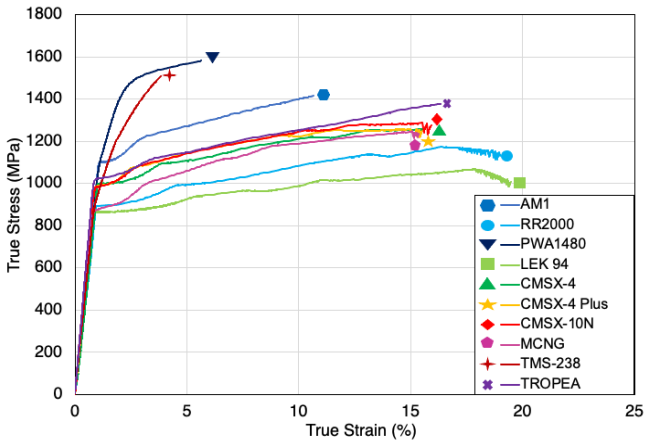

Fig.1 Tensile behavior of various single crystal superalloys at 650°C, $\dot{\varepsilon}$ = 5.10^{-4} s^{-1}

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