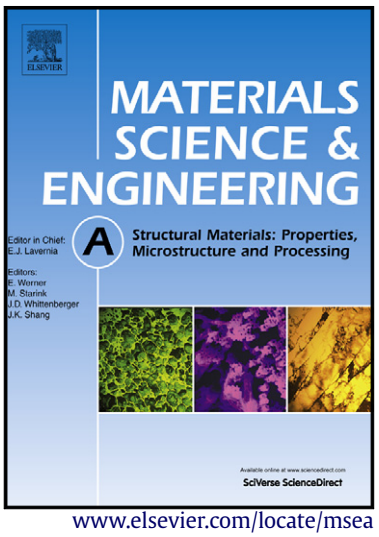

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Deformation and strength of Ti-6Al-4V alloyed with B at cryogenic temperatures

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Abstract: Plastic deformation and strength of Ti-6Al-4V (Ti64) alloyed with minor additions of B at cryogenic temperatures were investigated through unnotched and notched tensile tests at 20 and 77 K. Marked microstructural refinement that occurs with the trace addition of B to Ti64 was exploited for examining the role of microstructural length scales on the cryogenic plastic deformation. The tensile tests were complemented with detailed microstructural characterization using transmission electron microscopy and electron back scattered diffraction imaging of the deformed specimens. Experimental results show that the addition of 0.30 wt.% and above of B to Ti64 reduces ductility, and in turn enhances the notch sensitivity to the extent that those alloys become unsuitable for low temperature applications. However, the addition of ~0.10 wt.% B is beneficial in enhancing the low temperature strength. An examination of the yield strength variation at various temperatures reveals that at 77 K, the colony size determines the yield strength of the alloy, just as it does at room temperature; implying dislocation-mediated plasticity continues to dominate up to 77 K. At 20 K, however, twinning dominates the flow response, with the activation of $\{11\bar{2}1\}$ and $\{5\bar{6}\bar{1}3\}$ twinning in addition to $\{10\bar{1}2\}$ in the base alloy resulting in enhanced ductility of it as compared to either B-modified alloys at 20 K or the base alloy itself at 77 K. The observation of a reasonable correlation between the lath aspect ratio, given by the colony-to-lath thickness ratios, and yield strength variation at 20 K suggests that coarse colony size in the base alloy allows for the activation of additional twinning mechanisms.

Keywords: Titanium alloys; Cryogenic temperature; Plastic deformation; Twinning; Microstructure refinement.

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