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A methodology to investigate size scale effects in crystalline plasticity using uniaxial compression testing

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Abstract

A methodology for performing uniaxial compression tests on samples having micron-size dimensions is presented. Sample fabrication is accomplished using focused ion beam milling to create cylindrical samples of uniform cross-section that remain attached to the bulk substrate at one end. Once fabricated, samples are tested in uniaxial compression using a nanoindentation device outfitted with a flat tip, and a stressâ€“strain curve is obtained. The methodology can be used to examine the plastic response of samples of different sizes that are from the same bulk material. In this manner, dimensional size effects at the micron scale can be explored for single crystals, using a readily interpretable test that minimizes imposed stretch and bending gradients. The methodology was applied to a single-crystal Ni superalloy and a transition from bulk-like to size-affected behavior was observed for samples 5Â Î¼m in diameter and smaller.

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Keywords

Size scale effects; Micro-compression testing; Focused ion beam milling; Nickel superalloys

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