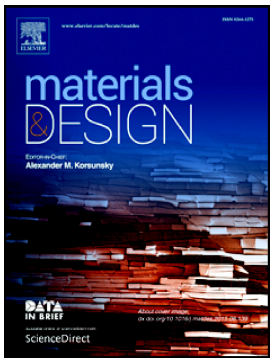

A new critical point on the stress-strain curve: Delineation of dynamic recrystallization from grain growth

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A new critical point on the stress-strain curve: delineation of dynamic recrystallization from grain growth

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Abstract

A new critical point termed 'stabilisation stress' (σ_{stab}) is identified in high temperature stress-strain curves. σ_{stab} represents the beginning of a stage in the hot working process where grain growth becomes the dominant microstructural phenomenon. This point is detected using an irreversible thermodynamics approach. Predicted correlations between σ_{stab} and grain growth are experimentally validated for structural steels, enabling the delineation of dynamic recrystallization from grain growth based on stress-strain curves.

Keywords: Hot deformation, dynamic recrystallization, grain growth, thermodynamics of plasticity.

1. Introduction

Deformation behaviour of metallic materials at elevated temperatures is influenced by various microstructural phenomena such as dynamic recovery (DRV), dynamic recrystallization (DRX) and grain growth. For a large number of engineering materials, including many steels, these phenomena result in a characteristic shape of the stress-strain curve [1]. When subjected to compression or torsion, these materials typically exhibit a single stress peak followed by softening and saturation of flow stress. Such 'single peak' curves are understood to represent grain refinement, as opposed to 'multiple peak' curves, which indicate grain coarsening [1, 2].

Through seminal contributions by various researchers, it is now possible to directly determine onset of DRX [3] and separate the effects of DRX from DRV [4, 5] by a simple analysis of such 'single peak' flow curves. In recent years, this capability has been combined with mathematical models to efficiently model the DRX process in different materials [6-8]. A major effort in these studies has been to predict, model and optimise the recrystallized