Characterization of Portevin - Le Chatelier Effect in the Industrial Alloy Al - 2.5% Mg

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Abstract

The unstable plastic flow constitutes a major inconvenient during the formability of metallic materials. The Portevin-Le Chatelier (PLC) is one of these plastic heterogeneities. It leads to heterogeneous mechanical properties, reduces the ductility of the deformed material and creates areas very sensitive to the corrosion. The strain localization zones are characterized by a dilating behavior which can cause the material rupture and, consequently, the failure of structures. The optimization of the homogeneous material formability is based mainly on the results of characterization and modelling of the unstable plastic flow. PLC instabilities are observed in different materials with different histories and in different conditions. The microscopic origin of the PLC effect is associated to the dynamic strain aging (DSA) phenomenon resulting from the interaction between mobile dislocations and the clouds of impurities. The solute atoms diffuse towards dislocations during their temporary arrests at local obstacles and increases, consequently, the plastic flow stress. The purpose of the present work is focused on the analysis of the temporal aspects of the PLC effect in the Al-2.5%Mg alloy at room temperature. We are interested to the determination of the domain of appearance of PLC plastic instabilities and to the study of the influence of the strain and the strain rate on the characteristic parameters of the unstable plastic flow. The most important parameters of nonuniform deformation of the Portevin-Le Chatelier effect are re-examined. Through uniaxial tensile tests, along the rolling direction, the amplitude of serrated yielding, the reloading time, the strain rate sensitivity and the critical strain for the onset of jerky flow have been studied and discussed as a function of strain and strain rate at room temperature.

Keywords: Portevin characterization, Le Chatelier Effect