PORTEVIN-LE CHATELIER EFFECT IN ALMG3% STUDIED USING ELEVATED TEMPERATURE NANOINDENTATION

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The Portevin-Le Chatelier (PLC) is a plastic instability observed in different alloys, and particularly in aluminum alloys, which is characterized by a serrated flow during plastic deformation. The PLC effect originates from the competition between gliding of mobile dislocations and pinning of these dislocations by diffusing solute atoms. This dynamic strain hardening leads to a negative strain rate sensitivity which is often used to characterize or quantify the PLC effect.

The PLC effect has been widely investigated in the case of stress-strain curves obtained in macroscopic uni-axial tests. However, in the case of the aluminum matrix composites Al/AlCuFe, it has been observed that copper atoms diffuse during the material synthesis form the reinforcement particles to the aluminum matrix. The aluminum matrix thus presents a heterogeneous concentration of copper atoms leading to local PLC effect. Nanoindentation test is the best way to characterize locally this mechanical effect. However, strain rate is not a convenient parameter for nanoindentation tests since the complex strain field below the indent, as well as the increase of the contact area during the test, makes difficult the definition a single strain value. Another way to investigate a local PLC effect would be thus the perform nanoindentation tests at different temperatures rather than different strain rates.

This poster will present experimental results from elevated temperature nanoindentation studies on an AlMg3% alloy, used as a model material for easy comparison with uniaxial tests, in the temperature range from 25-300°C. The experiments were performed in displacement controlled mode in a recently developed vacuum high temperature nanoindenter based on active surface referencing and non-contact tip and sample heating. In this configuration, the PLC effect appears as successive load drops on the loading curves. The temperatures of the tip and the sample surface were calibrated and matched in order to minimize thermal drift. With increasing temperature, the magnitude of load drop decreased whereas its occurrence frequency increased. The load drop magnitude and its occurrence frequency were statistically analyzed for different temperatures of testing. The results will be discussed in terms of an expanding plastic volume beneath the indenter interacting with the solute atoms in the complex stress field of the indenter.