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Multiscale investigation of the influence of the surface mechanical attrition treatment on the Portevin-Le Chatelier effect in an Al3%Mg alloy

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Various processes of severe plastic deformation have been elaborated since the 1970s to increase the mechanical and functional properties of metals and alloys. The surface mechanical attrition treatment (SMAT) belongs to recently suggested processes aimed at creating gradient microstructures. It allows to increase the dislocation density locally and may result in the grain refinement in a surface layer. Since industrial alloys are often subject to plastic instability – the Portevin - Le Chatelier (PLC) effect associated with deformation bands which often nucleate in the surface region – the investigation of the influence of SMAT on the PLC effect is of great interest. Due to a complex nature of the instability, which is controlled by the self-organization of crystal defects and, therefore, involves various physical scales, such a study has to include various experimental and theoretical approaches aimed at examining distinct scales of the deformation processes. This talk will present results of a multiscale investigation of the effect of SMAT on the plastic deformation in an AlMg alloy, including its macroscopic mechanical properties, the manifestations of stress serrations, the nucleation and formation of deformation bands visualized with the aid of the digital image correlation technique, the acoustic emission generated by the deformation processes. The experimental study will be supported by statistically based analyses adapted from the theory of nonlinear dynamical systems and numerical simulation based on an elasto-visco-plastic model of the PLC effect.

Keywords: Portevin-Le Chatelier effect, surface mechanical attrition treatment, complexity of plastic flow, acoustic emission, digital image correlation, statistical analysis.