

Thermographic study of nucleation and propagation of Portevin-Le Châtelier bands

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The occurrence of Portevin-Le Châtelier (PLC) effect in some materials is under the condition of certain temperature and strain rate. According to physical explanation, local deformation patterns of plastic instability rely on dynamical strain aging, dislocation interaction and negative strain rate sensitivity. The purpose of this work is the investigation of the nucleation and propagation of PLC deformation bands in Aluminium alloys. In particular, the morphology and kinematics of PLC bands are investigated experimentally using both mechanical and thermal measurement methods. The latter employs a high speed IR camera which captures temperature changes resulting from mechanical dissipation and heating due to the nucleation and propagation of PLC bands. Moreover, the algorithm of image correlation is utilised to calculate the plastic deformation from the contrast due to the roughness of surface. The simultaneous measurement of plastic deformation and temperature increment is a meaningful method to research the relationship between the local plastic deformation and heat dissipation. The measurements yield correlations between the spatiotemporal evolution of stress, strain and temperature in the specimens and PLC-band development. The dependence of band velocity and strain concentration on strain and strain rate is measured. Further the critical strain is measured with the change of strain rate.

Keywords: Portevin-Le Châtelier (PLC) effect; Dynamic strain ageing (DSA); Thermography; Digital image correlation

This paper was published in the QIRT Journal 5.2