NANOINDENTATION STUDY OF THE TEMPERATURE DEPENDENCE OF PLASTIC INSTABILITY IN AL ALLOYS

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Plastic instability, i.e. repetitive yielding that occurs during plastic deformation at low strain rates and moderately high temperatures, results in severe strain localization, reduction in ductility and formation of surface striations during forming processes. In order to gain insights into the different rate controlling mechanisms that govern PLC type plastic instability, it is useful to probe its thermal dependence. Such investigations facilitate the estimation of thermally activated parameters associated with the phenomenon and provide insights into the underlying microscopic mechanisms. In this work, we present an elevated temperature nanoindentation test method for characterizing the thermal dependence of plastic instability and assessing the activation energy associated with the phenomenon in Al–Mg and Al–Li based alloys. The method exploits the nanoscale force–displacement resolution capabilities of the nanoindenter, precludes the ambiguities inherent in the uniaxial testing based methods and offers increased reliability because of the statistical significance of the data achieved. Results show that the activation energies established by this method for these two alloys are consistent with values derived with other methods, and reflect the different rate controlling mechanisms associated with plastic instability in these alloy systems.

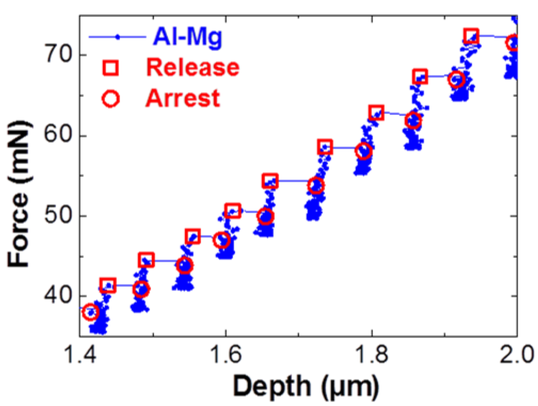

Figure 2: Force displacement response of Al-Mg at room temperature. Dislocation avalanche release (open squares) and arrest (open circles) points are highlighted.

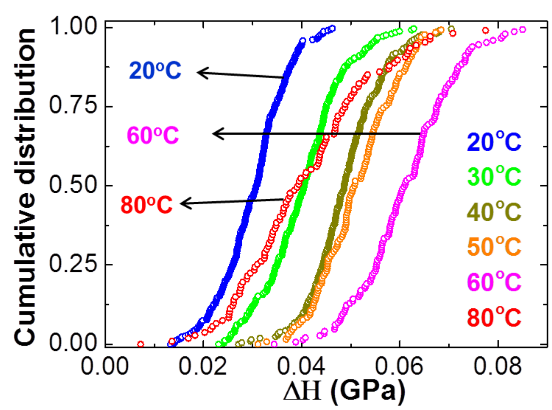

Figure 1: Cumulative distribution of the difference in hardness (ΔH) between a release point and the preceding arrest point as a function of temperature