PLASTIC AND ANELASTIC DEFORMATION AND MECHANICAL SOFTENING OF $Pd_{40}Cu_{30}Ni_{10}P_{20}$ BULK METALLIC GLASS DURING NANOINDENTATION

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Nanoindentation tests of $Pd_{40}Cu_{30}Ni_{10}P_{20}$ bulk metallic glass were performed over a wide range of indentation rates (from 0.04 up to 6.4 mN s^{-1}) under the standard load control mode. New results using the feedback displacement control mode are also presented. The dependence of the pop-in formation on the loading rate is investigated. A softening effect occurs when increasing the loading rate. This is explained by the differences in plastic deformation achieved at different indentation rates. The displacement control mode was used to avoid the shear localization of the free volume, leading to the almost complete absence of pop-ins along the loading curve. The obtained results suggest that plastic flow in bulk metallic glasses is governed by the rate of creation of free volume, which depends on the strain rate, and its localization into shear bands. Furthermore, time-dependent deformation processes during nanoindentation have been investigated. Deformation under constant load has been characterized as a function of prior loading rate and temperature. The constant-load displacement of the indenter into the sample shows classic relaxation kinetics and reveals the importance of anelasticity for the overall mechanical behavior of metallic glasses at the nanoscale.