Quantitative mapping of the nanoscale strain field in metallic glasses during in situ deformation

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Metallic glasses (MGs) are attracting wide interest due to their unique properties such as high strength and good wear resistance but their successful application is hindered by their low ductility at room temperature [1]. A fundamental understanding of nanoscale deformation mechanisms in glassy materials is to date limited to colloidal solids or molecular dynamics simulations [2]. Therefore, *in situ* deformation of a MG is carried out in a transmission electron microscope (TEM) to unravel the local nanoscale deformation processes. A bulk CuZrAlAg MG rod is produced by suction-casting and samples for compression and tension tests are extracted by focused ion beam milling. Deformation is carried out using a Hysitron PI-95 Picoindenter. The disordered nature of the MG inhibits direct imaging of the local atomic structure. Therefore, to unravel the early stages of deformation localization, we measure the evolution of the local elastic strain during *in situ* deformation with nanometer resolution [3]. Our method is based on scanning nanobeam electron diffraction. A nanosized electron beam is rastered over the sample and a full diffraction pattern is recorded for every probe position. The strain is determined by fitting an ellipse to the first order diffraction ring. To perform strain mapping during continuous deformation without stopping or pausing the experiment we make use of a Gatan K2 IS direct electron detector operating at a rate of 400 frames/s. The strain maps recorded during *in situ* deformation reveal significant strain inhomogeneities already in the linear elastic regime, demonstrating the importance of nanoscale structural variations in metallic glasses.

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