Mechanical Properties of a $Cu_{46}Zr_{54}$ Bulk Metallic Glass with Embedded Nanocrystal Particles

Andrés A. Manelli[*], Franco Ardiani[§], Carlos J. Ruestes[‡], Diego Tramontina[‡], Claudio A. Careglio[§††] and Eduardo M. Bringa[‡†]

[*,§]Facultad de Ingeniería, Universidad Nacional de Cuyo
Centro Universitario, 5500 Mendoza, Argentina
andresmanelli@gmail.com, francoamg@gmail.com, ccareglio@uncu.edu.ar

[††]ITIC, Universidad Nacional de Cuyo
Centro Universitario, 5500 Mendoza, Argentina

[‡]FCEN, Universidad Nacional de Cuyo,
Centro Universitario, 5500 Mendoza, Argentina,
cjruestes@hotmail.com, diego.tramontina@gmail.com,ebringa@yahoo.com

[†]CONICET, 5500 Mendoza, Argentina

ABSTRACT

Plasticity in bulk metallic glasses (BMGs), is normally dominated initially by shear transformations zones (STZ), which expand to form shear bands (SB) through the material. In order to control and thus improve the dynamics of plasticity, the composition of the metallic glasses is modified in different ways [1-3].

Particularly, the inclusion of nanocrystals provides obstacles to SB propagation and growth, with SB often nucleating at the interface between the BMG and the nanoparticle [1]. This results in a reduced and more homogeneous deformation in the plastic regime. Nevertheless, to ensure lasting effects, the inclusions should be stable in time, i.e. not diffuse into the surrounding amorphous material loosing the sharp transition from crystal to amorphous.

In previous work [5] we determined constitutive parameters of the $Cu_{46}Zr_{54}$ metallic glass as a function of temperature, using atomistic Molecular Dynamics (MD) simulations. We will now present results for two different types of inclusions: FCC copper and B2-CuZr sphere-shaped nanocrystals. Although we won't focus on the size effects of inclusions like other works [3-4], we analyse the stability of the nanoparticles at different temperatures. During mechnical deformation of a BMG sample with inclusions, we analize Voronoi polyhedra, and shear stress and shear strain localization to study the role of the inclusion in the mechanical properties of this composite material.

REFERENCES

[1] K. Albe et al, “Enhancing the plasticity of metallic glasses: Shear band formation, nanocomposites and nanoglasses investigated by molecular dynamics simulations”, *Mech. Mater.*, **67**, 94-103 (2013).
[2] S. Adibi et al, “A transition from localized shear banding to homogeneous superplastic flow in nanoglass”, *Appl. Phys. Lett.*, **103**, 211905 (2013).
[3] S. Adibi et al, “Composition and grain size effects on the structural and mechanical properties of CuZr nanoglasses”, *J. Appl. Phys.*, **116**, 043522 (2014)
[4] A. C. Lund et al, “Critical length scales for the deformation of amorphous metals containing nanocrystals”, *Philos. Mag. Lett*., **87(8)**, 603-611 (2007)
[5] F. Ardiani, A. Manelli et al, “Atomistic simulations of amorphous metals in the elasto-plastic regime”, *Mec. Comput.,* **31**, 1437-1449 (2012).