# Ductile amorphous oxide coatings and their key enabling role for next generation nuclear technologies: heavy liquid metal cooled fast reactors and fusion

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In this seminar I will present our recent results on ductile amorphous oxide coatings and their key enabling role for next generation nuclear technologies: heavy liquid metal cooled fast reactors and thermonuclear fusion. These unique class of amorphous ceramics exhibits an elastoplastic response under both tensile and compressive tests at room temperature (E. Frankberg et al. Science, 2019). A yield stress as high as 4 GPa (tensile and compressive) has been measured, with a plastic deformation as high as 7% in tension and 100% in compression. Whilst we are still investigating the exact microscopic mechanism is still unknown, we observed that the plastic deformation of the material resembles viscous flow, in which no observable necking occurs and the stress is proportional to strain rate with no other strengthening mechanisms observed. This initial finding suggests that viscous creep of amorphous materials can be activated even at room temperature if sufficiently high stress levels can be reached, hence inducing yielding instead of brittle fracture. The experimental and theoretical work performed so far portrait a scenario in which three conditions seem to be necessary: structural homogeneity; high mass/atomic density; absence of defects down to the nm range; bonds flexible enough to undergo changes in coordination number as well as of neighbour. SEM *in situ* micromechanical tests suggest that this elastoplastic behaviour is maintained even for volumes of several microns cube. We studied how this amorphous oxides behaves under heavy ion irradiation finding a peculiar crystallization behaviour with dose, with detectable damages only above 150 dpa (F. G. Ferré et al. Scientific Reports 2016). Besides these unique mechanical properties, the amorphous oxide coatings exhibit extreme stability under thermal stresses, near zero permeability to gases and inertness with respect to heavy liquid metal (Pb, PbBi, LiPb) corrosion. Indeed, we will show how these materials, by in the form of coatings on structural steels, are key for next generation fast nuclear reactors and magnetically confined nuclear fusion, enabling the design of innovative and economically attractive power plants.

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