Materials research with high-energy synchrotron radiation

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Compared with crystalline counterparts, metallic glasses (MGs) have some superior properties, such as high yield strength, hardness, large elastic limit, high fracture toughness and corrosion resistance, and hence are considered as promising engineering materials. Fe- and Co-based amorphous alloys have been the subject of considerable research interest and activities for the last decades due to applications related to their outstanding soft magnetic properties. Structurally, metallic glasses can be classified as disordered materials. X-ray diffraction (XRD) using high-energy photons has proven to be well suited for describing the structure of highly disordered systems such as MGs. Time-resolved in situ XRD experiments may nowadays be performed at high-brilliance synchrotron radiation sources for a variety of conditions which help to elucidate the structure–property relations.

The first part of this talk will present the results of structural changes occurring in Fe-based MG during a combination of constant rate heating (20 K/min) and isothermal holding at 500 and 520 C investigated using in situ high-energy X-ray diffraction. It was found that the ferromagnetic-to-paramagnetic transition of the amorphous phase is revealed as a change in the slope of the thermal expansion curve when heating a sample at a constant rate up to 520 C. Real space analysis by means of the atomic pair distribution function (PDF) demonstrated that the rate and extent of the thermal expansion strongly depend on the interatomic separation. In the second part of the talk a new setup for extremely fast heating in-situ XRD experiments will be introduced. Preliminary results collected on Fe-based MG will demonstrate the use of the technique in the study of crystallization phenomena. The last part of the talk will be devoted to the study of strain-induced anisotropy in nanocrystalline Fe-based soft magnetic alloy. Methodology of strain pole figure measurements using high-energy synchrotron radiation will be presented.