

NOMATEN Hybrid Seminar

Location: NOMATEN seminar room

Time: 1 PM

gotomeeting room (for online): <https://meet.goto.com/NCBJmeetings/nomaten-seminar>

Seminar date: January 8th, 2025

Title: Enhancing the mechanical properties of an additive manufactured Zr-based bulk metallic glass

Speaker name: Prof. Jamie J. Kruzic

Speaker affiliation: University of New South Wales (UNSW Sydney), Sydney NSW 2052, Australia.

Abstract: Laser powder bed fusion (LPBF) enables the fabrication of large-dimensional bulk metallic glass (BMG) components; however, we are only just learning how to control the LPBF process to obtain specific mechanical properties. LPBF was used to produce dense and fully amorphous Zr_{59.3}Cu_{28.8}Nb_{1.5}Al_{10.4} BMG samples from two different starting powders. One powder had a relatively finer particle size range of 10-45 µm and the other had a relatively coarser particle size range of 25-63 µm. Fully amorphous samples were achieved for both powders within a large processing window of laser power and scanning speed combinations. When the LPBF volumetric energy density was raised above ~30-33 J/mm³, high relative density (> 99%) was maintained along with devitrification and embrittlement. Low LPBF energy densities below ~20 J/mm³ produced low relative density (< 99%) and fully amorphous samples. Strength and hardness generally increased with increasing LPBF energy density while the relaxation enthalpy, ductility, and fracture toughness decreased. Furthermore, the coarser powder had four times lower oxygen content and gave better glass forming ability, compression ductility up to 6% plastic strain, and fracture toughness up to ~38 MPa√m. These findings demonstrate that it is possible to tailor the structure and mechanical properties of BMGs by tuning the LPBF process parameters within a wide processing window and by controlling the feedstock powder oxygen content.

Bio: Prof. Jamie Kruzic joined UNSW Sydney as a professor of mechanical and manufacturing engineering in 2016, and he held the position of Deputy head of school from 2017 to 2023. His research focuses on the mechanical behaviour of a wide range of engineering materials (metals, ceramics, intermetallics, composites), biomaterials, and biological tissues, with emphasis on the mechanisms of fracture, fatigue, and deformation. Professor Kruzic is the recipient of a Friedrich Wilhelm Bessel Research Award of the Alexander von Humboldt Foundation. Through this program, he joined the chair of the metallic materials of TU-Berlin for a few months research stay within the group of prof. Gallino.

Title: On the glass transition of metallic glasses studied via fast scanning calorimetry

Speaker name: Prof. Isabella Gallino

Speaker affiliation: Technical University Berlin, Berlin, Germany

Abstract: Only recently, the development of fast differential scanning calorimetry (or chip-calorimetry)

has allowed us to characterize in situ the glass transition response of metallic glasses during cooling from the liquid over a wider range of time scales employing scanning rates from 100 K/s up to 50,000 K/s. The generally accepted description is that the vitrification kinetics should exhibit the same temperature dependence as the relaxation time for the alpha-process. However, we have recently observed that vitrification at deep undercooling may occur with a milder temperature dependence than the alpha-relaxation. The slower the system is cooled the more pronounced is the decoupling between these vitrification kinetics and the atomic mobility. As a consequence, vitrification can occur at fictive temperatures lower than those which would be obtained only accounting for the alpha-process. This apparent decoupling of the time scales for the vitrification kinetics from the time scales for the alpha-relaxation process is more pronounced at deep undercooling and for small sample sizes. This is of most importance because, it advocates a heterogeneity of cooperative atomic rearrangements, where faster mechanisms for atomic mobility that apparently are not contributing to the alpha-relaxation process, are maintaining the undercooled liquid system in (metastable) equilibrium and delay vitrification to lower temperatures.

[1] V. Di Lisio, I. Gallino, S. S. Riegler, M. Frey, N. Neuber, G. Kumar, J. Schroers, R. Busch, D. Cangialosi, Size-dependent vitrification in metallic glasses, *Nature Commun.* 14 (2023) 4698.

[2] X. Monnier, D. Cangialosi, B. Ruta, R. Busch, I. Gallino, Vitrification decoupling from α -relaxation in a metallic glass, *Science Advances* 6, eaay1454 (2020).

Short bio: Isabella Gallino was educated in Italy and in the USA. She received a degree in Chemistry from the University of Turin and a Ph.D. degree in Materials Science and Engineering from the Mechanical Engineering department of the Oregon State University. In 2005, she moved to Saarland University in Germany as a Group Leader and pursued her Habilitation in the field of Metallic Glasses.

In January 2024, she joined the Technical University of Berlin as Full Professor leading the Chair of Metallic Materials and the Research Center of Extrusion.

Her research interests are in the field of physical metallurgy and include both fundamental science and technical aspects, such as the thermophysical properties of bulk metallic glass-forming liquids and the development of innovative metal processing techniques and the discovery of new alloy compositions for commercial applications.

She is also the Chair of the Metals Staging Group of the Materials Research Society (MRS) and Editor of *Materials Research Letters*.

