Extending the Range of the Glassy State: Insights from Metallic Glasses

A. L. Greer[1,*,#]

[1]University of Cambridge, Department of Materials Science & Metallurgy, 27 Charles Babbage Road, Cambridge CB3 0FS, UK.

[#]Corresponding author: alg13@cam.ac.uk

Focusing on metallic systems, we consider developments in understanding and exploiting the glassy state that is formed when a liquid is cooled into a solid state without crystallizing, having in mind that: "The deepest and most interesting unsolved problem in solid state theory is probably the theory of the nature of glass and the glass transition" [1]. The metallic glasses are of particular interest for several reasons, not least their excellent mechanical properties. These lead to possible applications, but also open up the possibility of using mechanical working to change the structure and properties of glass [2], something hardly explored for conventional oxide glasses. While plastic deformation can be expected to have structural effects, it is more surprising that there can be significant effects even well within the (nominally) elastic regime [3,4]. In this talk we explore the diversity that can be achieved in the metallic glassy state, from very high energy ('rejuvenated') to very low energy ('relaxed' and even 'ultrastable') states [5]. We also explore the extent to which directionality (anisotropy) can be induced in metallic glasses [6]. In each case, we examine the potential applications of the properties (structural and functional) that can be induced.

[1] P.W. Anderson, *Science* **267**, (1995) 1615.
[2] Y.H. Sun, A. Concustell, A.L. Greer, *Nature Rev. Mater.* **1**, (2016) 16039.
[3] S.V. Ketov, Y.H. Sun, S. Nachum, Z. Lu, A. Checchi, A.R. Beraldin, H.Y. Bai, W.H. Wang, D.V. Louzguine-Luzgin, M.A. Carpenter, A.L. Greer, *Nature,* **524**, (2015) 200.
[4] A.L. Greer, Y.H. Sun, *Philos. Mag.* **96**, (2016) 1643.
[5] A.L. Greer, *Nature Mater.* **14**, (2015) 542.
[6] Y.H. Sun, A. Concustell, M.A. Carpenter, J.C. Qiao, A.W. Rayment, A.L. Greer, *Acta Mater.* **112**, (2016) 132.