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HKIAS Distinguished Lecture

Extending the Applicability of the Glassy State of Matter

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Date : 11 April 2019 (Thursday)
Time : 4:30pm - 6:00pm *(Light refreshments will be served from 4:00pm to 4:30pm)*
Venue : Connie Fan Multi-media Conference Room, 4/F, Cheng Yick-chi Building
City University of Hong Kong

Abstract

"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]; certainly glasses, lacking the order of crystals, are still poorly understood. Yet glasses also show remarkable correlations of properties across different chemistries, and here we focus on recent research on non-conventional metallic, carbohydrate and chalcogenide systems.

Metallic glasses have excellent, even record-breaking, mechanical properties. Mechanical working can be used to change their structure and properties [2], something hardly explored for conventional (e.g. oxide) glasses. While plastic deformation is expected to have structural effects, it is surprising that there are significant effects even well within the (nominally) elastic regime [3,4]. The focus of interest is 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.

The formation of carbohydrate glasses is critical in ensuring that living organisms can resist death by desiccation or freezing [5], with many implications for pharmaceutics and medicine.

Chalcogenide glasses can switch fast to the crystalline state and back; this can be exploited in non-volatile computer memory. Ultra-fast differential scanning calorimetry can characterize crystal growth rates up to their maxima at intermediate supercooling [6]. Studies of fast crystallization are directly relevant for memory performance, and may even point to the application of pure metals for fast switching [7].

[1] PW Anderson, Through the glass lightly, Science **267** (1995) 1615–1616.

[2] YH Sun, A Concustell, AL Greer, Thermomechanical processing of metallic glasses: extending the range of the glassy state. Nature Rev. Mater. **1** (2016) 16039.

[3] SV Ketov, YH Sun, S Nachum, Z Lu, A Checchi, AR Beraldin, HY Bai, WH Wang, DV Louzguine-Luzgin, MA Carpenter, AL Greer, Rejuvenation of metallic glasses by non-affine thermal strain, Nature **524** (2015) 200–203.

[4] AL Greer, YH Sun, Stored energy in metallic glasses due to strains within the elastic limit, Philos. Mag. **96** (2016) 1643–1663.

[5] KF Kelton, AL Greer, Nucleation in Condensed Matter: Applications in Materials and Biology, Elsevier, Amsterdam (2010), pp. 630–633.

[6] J Orava, AL Greer, B Gholipour, DW Hewak, CE Smith, Characterization of supercooled liquid Ge2Sb2Te5 and its crystallization by ultra-fast-heating calorimetry, Nature Mater. **11** (2012) 279–283.

[7] AL Greer, New horizons for glass formation and stability, Nature Mater. **14** (2015) 542–546.

Biography

At the University of Cambridge, Lindsay Greer is Head of the School of the Physical Sciences, and was (2006–2013) Head of the Department of Materials Science & Metallurgy. He received his MA and PhD degrees from Cambridge, where he was a student at Trinity Hall. He was briefly a Research Fellow at Churchill College, and is now a Fellow of Sidney Sussex College, where he was for some time Vice-Master. He holds an Honorary Doctorate from AGH University of Science & Technology, Cracow, Poland. He was a NATO Research Fellow and Assistant Professor of Applied Physics at Harvard University, and has held visiting positions at the CEA and INP Grenoble, Washington University (St Louis, USA), and the Universities of Vienna and Turin. He is a Foreign PI of the Advanced Institute for Materials Research, Tohoku University (Sendai, Japan).

His research interests are metallic glasses and crystal nucleation, grain refinement in casting, and chalcogenide thin films for phase-change data storage. Prof. Greer holds an ERC Advanced Grant.

All are welcome

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