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Tian, K.V.; Yue, Yuanzheng; Fang, D.C.; Chass, G.A.; Greaves, G.N.

Publication date:
2014

Document Version
Accepted author manuscript, peer reviewed version

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Tian, K. V., Yue, Y., Fang, D. C., Chass, G. A., & Greaves, G. N. (2014). *Tracking Setting Dynamics in Cementitious Materials*. Abstract from Atomistic Modelling Workshop and 2nd Glass Summit, Wuhan, China.

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Tracking Setting Dynamics in Cementitious Materials

Kun V. Tian,^a Yuanzheng Yue,^{b,c} De-Cai Fang,^d Gregory A. Chass,^{e,*}
and
G. Neville Greaves,^{b,f,g,*}

^a Materials Science Research Institute, Semmelweis University, Budapest, Hungary

^b State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan 430070, China

^c Section of Chemistry, Aalborg University, DK-9000 Aalborg, Denmark

^d Key Laboratory of Theoretical and Computational Photochemistry, ministry of Education, College of Chemistry, Beijing Normal University, Beijing 100875, China

^e School of Biological and Chemical Sciences, Queen Mary University of London, London, UK

^f Department of Materials Science and Metallurgy, University of Cambridge, Cambridge, UK

^g Institute of Mathematics, Physics and Computer Science, Aberystwyth University, Aberystwyth, UK

Despite increasing demands for improved biomaterials, rational design and optimisation remains incomplete. Glass ionomer cements (GICs), widely used in dentistry and orthopaedics (Fig.1), offer apposite examples, combining glass brittleness with polymer ductility - but a resultant composite insufficiently tough for load-bearing applications. Using a combination of *in situ* spectroscopies, we have discovered how toughness at the atomic level varies non-monotonically during setting. Transmission Electron Microscopy (TEM) and Differential Scanning Calorimetry (DSC) identify phase separation, the latter also evidencing high thermal stress in the glass component. Neutron Compton Scattering (NCS) identifies a setting point, where decreasing toughness momentarily recovers. Concurrent Structure Factor variations point to associated weaknesses developing at the glass-matrix interface, while Coherent Terahertz Spectroscopy reveals the coupling point where both components engage. Quantum chemical calculations modelling the hybrid interface, predict the collective vibrations that drive coordination modifications governing toughness.

The talk covers the results on glass cements, with a focus on the insight afforded by these correlated studies which may well help to open the way to design new generation composite materials with optimal practical and clinical performance.

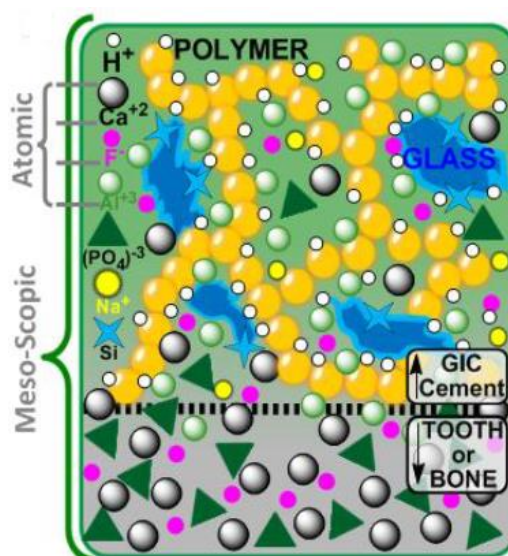


Fig.1 Illustration of the multi-scale structure and ion-exchange interface of bioactive glass-cement