MAR15-2014-020308

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Surface Diffusion of Molecular Glasses and Its Role in Crystal Growth and Glass Engineering[1]

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Amorphous solids and glasses are important in many areas of science and technology. We report recent progress toward measuring surface diffusion on molecular glasses. A rough surface flattens to minimize its surface energy and this process occurs by surface diffusion at short length scales. Surface diffusion on molecular glasses is at least one million times faster than bulk diffusion,[1,2] and remains fast after significant bulk aging.[3] This high surface mobility enables fast surface crystal growth[4] and the formation of stable glasses by vapor deposition.[5] Relying on rapid surface equilibration, vapor deposition can build glasses layer-by-layer to achieve exceptionally low energy and high density. A remarkable feature of glass-forming molecular liquids is that the mechanism of surface evolution transitions from viscous flow to surface diffusion at modest viscosities. Under the same condition, this transition is not observed for silicate and polymer liquids, indicating a material dependence of surface diffusion. (1) Zhu, L.; Brian, C.; Swallen, S. F.; Straus, P. T.; Ediger, M. D.; Yu, L. Phys. Rev. Lett. 2011, 106, 256103. (2) Brian, C. W.; Yu, L. J. Phys. Chem. A. 2013, 117, 13303. (3) Brian, C. W.; Zhu, L.; Yu, L. J. Chem. Phys. 2014, 140, 054509. (4) Sun, Y.; Zhu, L.; Kearns, K. L.; Ediger, M. D.; Yu, L. Proc. Natl. Acad. Sci. U. S. A. 2011, 108, 5990. (5) Swallen, S.; Kearns, K.; Mapes, M.; McMahon, R.; Kim, S.; Ediger, M.; Yu, L.; Wu, T.; Satija, S. Science 2007, 315, 353.

[1]NSF (DMR-1206724, DMREF-1234320)