Resolving Amorphous Solids - The Atomic Structure of a 2D Glass

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Vitreous silica is the basis of traditional glasses. Furthermore, it is the prototype oxide network former. Hence, it has been extensively investigated by diffraction methods, like X-ray and neutron scattering. Therefore, it is a great surprise how little is known about its atomic structure. It is impossible to directly extract ring statistics or local ring environments from diffraction. Theoretical structural models have been correlated to the diffraction data with reasonable agreement. Nevertheless, such agreement can never be unambiguously elucidate the structure of an amorphous material.

Modern imaging techniques render the investigation of two dimensional (2D) glass systems possible. Recently, we reported on the atomic structure of a thin metal-supported vitreous silica film on Ru(0001) using scanning tunneling microscopy (STM) [1]. For the first time, it was possible to verify Zachariasen's continuous random network [2] in real space. The existence of a 2D silica glass on a graphene support has been shown by scanning transmission electron microscopy [3] suggesting that further 2D glass systems may be prepared. The investigation of 2D glass models provides the unique possibility to study unexplored properties of amorphous materials.

Herein we report on the first non-contact atomic force microscopy (nc-AFM) images of a 2D silica glass grown on Ru(0001). We will present a thorough statistical analysis and a comparison to diffraction data of 3D silica glass as well as to theoretical models, hereby showing that a 2D thin film of vitreous silica can act as a model system for the amorphous 3D network.

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[2] W. H. Zachariasen, " The Atomic Arrangement in Glass", J. Am. Chem. Soc. 54, 3841 (1932).

[3] P. Y. Huang, S. Kurasch, A. Srivastava, V. Skakalova, J. Kotakoski, A. V. Krasheninnikov, R. Hovden, Q. Mao, J. C. Meyer, J. Smet, D. A. Muller, and U. Kaiser, "Direct Imaging of a Two-Dimensional Silica Glass on Graphene", Nano Lett., in press (2012).