# Graphene: An ideal substrate for TEM imaging and spectroscopy

S. Kurasch[1], P.Y. Huang[2], V. Skakalova[3], A. Srivastava[3], J. Kotakoski[4], A.V. Krasheninnikov[4], R.M. Hovden[2], Q. Mao[2], J.C. Meyer[5], J. Smet[3], D.A. Muller[2], U. Kaiser[1], [1]

[1] *University of Ulm, Germany*
[2] *Cornell University, Ithaca, USA*
[3] *Max Planck Institute for Solid State Research, Stuttgart, Germany*
[4] *University of Helsinki, Finland*
[5] *University of Vienna, Austria*

Due to the extremely low thickness, high mechanical stability, low contrast and good electrical and thermal conductivity graphene is an ideal TEM substrate for high resolution studies of deposited crystals or molecules [1,2]. Furthermore it is crystalline and the in-plane lattice spacing is very small. By this the contribution to the HRTEM image is known very well and can presisely be taken into account in the evaluation or be remove by Fourier filtering. This allows to determine the presise atomic configuration of grain boundaries in multiple layers of graphene that are found in CVD grown graphene samples and in high temperature in-situ experiments [3].

Here we demonstrate the strength of this approach for a 2D silica we discovered on graphene: For the first time it is possible to perform structural and spectroscopic (S)TEM studies of glassy materials on an atomic scale. It has been reported previously that crystalline 2D silica forms on Ru (0001) surfaces [4]. Additionally, on graphene we find an amorphous phase as well. The structural images strikingly resemble Zachariasen's cartoons of a 2D continuous random network glass [4].

[1] J. C. Meyer, A. K. Geim, M. I. Katsnelson, K. S. Novoselov, T. J. Booth and S. Roth , Nature, 446, 7131 (2007)
[2] R. S. Pantelic, J. W. Suk, C. W. Magnuson, J. C. Meyer, P. Wachsmuth, U. Kaiser, R. S. Ruoff and H. Stahlberg, Journal of Structural Biology, 174, 1 (2011)
[3] B. Westenfelder et al., Nano Lett., 10.1021/nl203224z (2011)
[4] B. Westenfelder, J. C. Meyer, J. Biskupek, S. Kurasch, F. Scholz, C. E. Krill III and U. Kaiser, Nano Letters, 10.1021/nl203224z (2011)
[5] D. Löffler, J. J. Uhlrich, M. Baron, B. Yang, X. Yu, L. Lichtenstein, L. Heinke, C. Büchner, M. Heyde, S. Shaikhutdinov, H.-J. Freund, R. Wodarczyk, M. Sierka and J. Sauer, PRL 105, 146104 (2010)
[6] W. H. Zachariasen, J. Am. Chem. Soc. 54, 3841âĂŞ3851 (1932)