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***In situ* growth of individual graphene layers**

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Chemical vapor deposition (CVD) is a relatively easy and cheap method for large scale synthesis of graphene. Commonly used catalysts are copper or nickel [1], [2] foils or wafers. However, the understanding and control of such growth processes are still in their infancy.

We present *in situ* transmission electron microscopy (TEM) experiments in a FEI Titan 80-300 Environmental TEM (ETEM) for studying the growth of layered carbon materials on these catalysts. The ETEM allows imaging with controlled gas environments around the sample up to a few mbar. In combination with a MEMS-based heating holder, growth of layered carbon materials is systematically studied at the atomic level using various gas pressures and growth temperature.

The growth of few layer graphene from C_2H_2 on a Ni catalyst is shown in Fig. 1. NiO particles in the size range up to a few hundred nm are reduced in the microscope under H_2 at 500-600°C in order to form a catalytically active Ni surface. Introducing C_2H_2 at about 650°C leads to growth of layered carbon. By following the appearance of carbon layers, the growth rate dependence on various parameters can be determined directly from the ETEM observations.

These results should help to better understand the growth mechanism and help to control and optimize the process.

References:

- [1] X. Li, W. Cai, J. An, S. Kim, J. Nah, D. Yang, R. Piner, A. Velamakanni, I. Jung, E. Tutuc, S. K. Banerjee, L. Colombo, and R. S. Ruoff, *Science* **324**, 1312 (2009).
- [2] X. Li, W. Cai, L. Colombo, and R. S. Ruoff, *Nano Lett.* **9**, 4268 (2009).

Images:

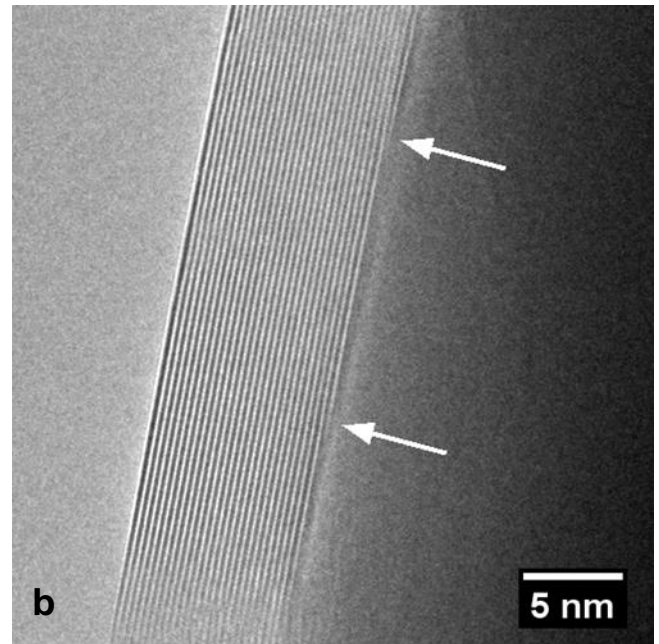
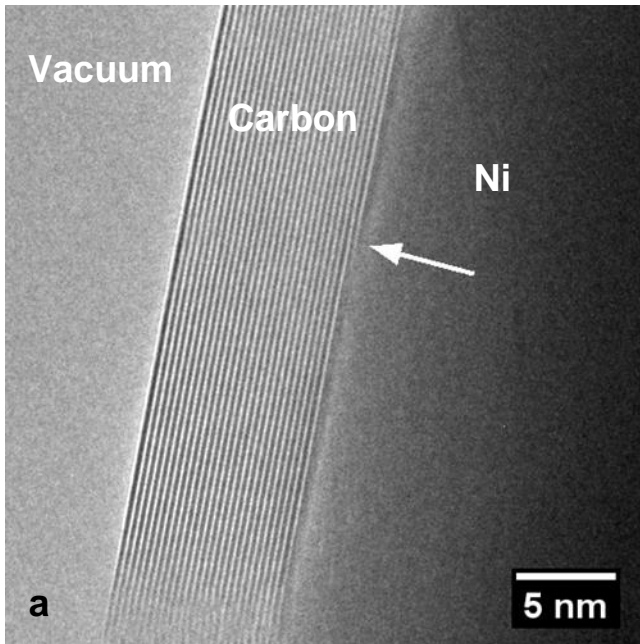


Fig. 1: Image series with 0.61s between the images. The in-plane growth of the carbon layers is easily observed (see arrows).