Scanning Probe Microscopy and Spectroscopy of Nanodiamonds and Graphene

Th. Glatzel, R. Pawlak, S. Stehlik, S.Koch, and E. Meyer

University of Basel, Department of Physics, Klingelbergstr. 82, 4056 Basel, Switzerland

Nanodiamonds (ND) and graphene are belonging to the most studied carbon based materials since they offer fascinating scientific properties and are promising for applications. Defect centers in NDs provide dedicated optical, magnetic, and electrical properties giving rise to a variety of possible applications including photonic devices, sensors, carriers for biomedical applications, and quantum information processing and computing. Diamond is a wide band gap material (5.5 eV) and is optically transparent from ultraviolet to the infrared. However, single optically-active defects within the lattice structure, such as Nitrogen-Vacancy centers (NV-1), adsorb and re-emit lights through the crystal and can be used to functionalize the material. In contrast graphene offers, among others, excellent electrical properties which are strongly influenced by rippling of the 2D layer, the interaction to the substrate and the defect density. The most common way of preparing graphene is the high temperature exposure (500-1000°C) of ethylene to copper, and other transition metal surfaces, which leads to the formation of large and homogeneous graphene layers. A lattice mismatch between the layers and the metal surfaces can cause superstructures influencing the electronic properties.

In the presentation nc-AFM, KPFM, and STM experiments will be discussed by showing the complexity of detonation NDs adsorbed on highly oriented pyrolitic graphite (HOPG) [1] and 2D graphene on Ru(0001) [2] which are observed in the topography as well as in the local contact potential difference images. We thoroughgoing investigate and discuss the tip-sample interaction by 2D dynamic force and tunneling spectroscopy at room and low temperature.

[1] R. Pawlak, T. Glatzel, V. Pichot, L. Schmidlin, S. Kawai, S. Fremy, D. Spitzer and E. Meyer, *Local Detection of Nitrogen-Vacancy Centers in a Nanodiamond Monolayer,* Nano Lett. **13**, 5803, (2013).

[2] S. Koch, D. Stradi, E. Gnecco, S. Barja, S. Kawai, C. Diaz, M. Alcami, F. Martin, A. L. Vazquez de Parga, R. Miranda, T. Glatzel and E. Meyer, *Elastic Response of Graphene Nanodomes,* ACS Nano **7**, 2927, (2013).