Ultra-thin h-BN films employed as STEM substrates for nanoscale plasmon spectroscopy

Alexander Schiffmann[1], Daniel Knez[2], Florian Lackner[1], Maximilian Lasserus[1], Roman Messner[1], Martin Schnedlitz[1], Ferdinand Hofer[2], and Wolfgang E. Ernst[1]

[1]*Institute of Experimental Physics, Graz University of Technology, Petersgasse 16, A-8010 Graz, Austria*
[2]*Institute of Electron Microscopy and Nanoanalysis & Graz Centre for Electron Microscopy, Graz University of Technology, Steyrergasse 17, A-8010 Graz, Austria*
alexander.schiffmann@tugraz.at

Ultra-thin hexagonal boron nitride (h-BN) films are employed as substrates for scanning transmission electron microscopy (STEM). The thickness of only a few atomic monolayers, the flat surface, and the relatively large bandgap of 5.97 eV [1] provide a unique set of properties, which makes h-BN ideally suited for high resolution plasmon spectroscopy by means of electron energy loss spectroscopy (EELS) [2]. The produced h-BN films have been placed on a holey carbon support (cf. Fig. 1a) and have an average thickness in the range of only 1 nm (~0.32 nm per monolayer [3]). H-BN is superior compared to commercially available substrates such as amorphous carbon and SiN_x regarding the signal-to-noise ratio of the acquired EELS signal and the zero-loss peak (ZLP) width.

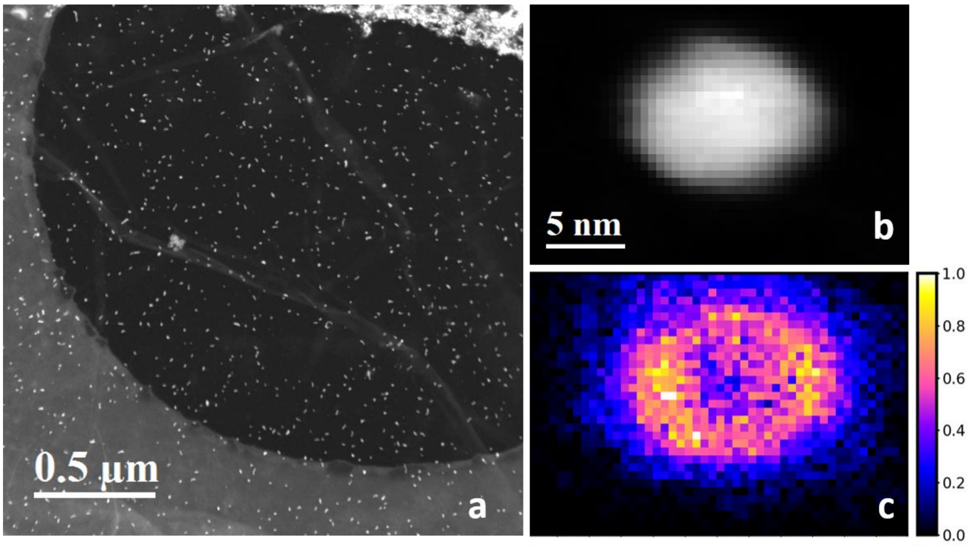

Fig. 1: (a) STEM image of the h-BN film on holey carbon support covered with nanoparticles, (b) detail of an Ag nanoparticle and (c) the corresponding normalised EELS map at 3.1 eV

We present results on the investigation of plasmon modes of Ag, Au, and Ag@Au core@shell nanoparticles which lie in the transparent energy range of the h-BN substrates [4]. The particles were fabricated utilizing the helium nanodroplet synthesis approach [5], allowing for a surfactant free production of tailored structures. Plasmon spectroscopy with EELS has the advantage of providing access to spectrally and energetically resolved plasmon resonance maps. For a single Ag particle in Fig. 1b the corresponding normalised EELS map at a loss energy of 3.1 eV is depicted in Fig. 1c.

References:
[1] Régis Decker *et al.*, Nano Lett. **11**, 2291-2295 (2011).
[2] Michel Bosman *et al.*, Nanotechnology **18**, 165505 (2007).
[3] Ki Kang Kim *et al.*, Nano Lett. **12 (1)**, 161-166 (2012).
[4] Michael B. Cortie and Andrew M. McDonagh, Chem. Rev. **111**, 3713-3735 (2011).
[5] Philipp Thaler *et al.*, J. Chem. Phys. **143**, 134201 (2015).