Nanotech

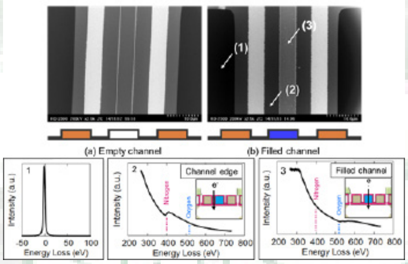
Ultra-Thin Nanochannel-Based Liquid TEM Cell for EELS Analysis and High Resolution Imaging

Host Professor Pr. H. FUJITA
Keywords TEM, Liquid Cell, Nanoparticles

Yusuf Bilgehan ARIK (MESA+)

Context Although electron microscope is powerful, specimens undergo destructive and difficult preparations, which precludes real time imaging of processes in liquid media. To broaden the scope of applications, working environment of TEM has been extended to gas-controlled conditions[1]. Furthermore, liquid cells have been developed where liquid is sealed within the cell preventing evaporation while the microscope is maintained at high vacuum conditions[2]. Current liquid TEM cells suffer from specific issues, a need for cumbersome assembly of two substrates and thick membrane limiting the imaging resolution.

Objectives & Methods We present a nanochannel-based liquid TEM cell for the observation of biomolecules in aqueous environment inside scanning TEM. It aims at achieving high resolution imaging using a sub-micron liquid layer surrounded by ultra-thin channel walls. Our state-of-the-art design features the monolithic fabrication of suspended nanochannels for TEM observation in liquid, resulting in better



fabrication yield and thinner walls as well as an adjacent vacuum area allowing liquid detection by electron energy loss spectroscopy (EELS). Finally, for the first time and thanks to our unique design, we confirm the presence of aqueous solutions in the nanochannels using EELS.

Results EELS measurements on different locations on the observation window are shown in Fig-1. Vacuum-area is used as control and for calibration. To compare, channel edge containing only silicon nitride and liquid containing channels (Fig-1e) are measured. Contrast difference between empty and filled channels strongly suggests the presence of water in the channel, which is confirmed by distinguishable oxygen peak (Fig-1e). Fig-2 shows the gold nanoparticles with sizes of 15nm in channels (measured resolution of 7.8±3nm (n=20)). We are currently optimizing the imaging resolution to observe biomolecules which have a lower contrast and are more challenging to visualize.

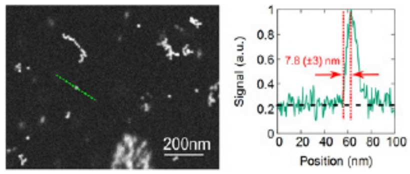


Fig. 2. Nanoparticle imaging in the liquid TEM cell.

References

[1] N. de Jonge et al. PNAS. 106:2159-2164, 2009
[2] A. Verch et al. Langmuir 31:6956-6964, 2015