Report on experiment CH-4000: Wettability of carbon nanotubes

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The experiment aimed to investigate the local kinetics of adsorption of water vapour in carbon nanotubes (CNTs).

The principle of the experiment is based on comparing the signal of the dry CNTs with that of samples that adsorb the probe molecules. Specimens were placed in 4mm ID glass tubes and held in contact with the vapour of a saturated aqueous solution of KCl (relative humidity RH=85 %) at fixed temperature (20ºC). The scattering measurements were conducted at 18 keV (to penetrate the 1⁄2 mm walls of the glass tubes) over the whole measurement period. The sample tubes were removed briefly from the vapour bath and then returned to it immediately after the measurement. Samples of two different pristine MWCNTs with different external diameter were investigated, each with two different degrees of oxidation. These were measured both in the intact state and after milling to determine the effects of shortening the CNTs. A control sample of activated carbon (Norit R1OX) was also investigated, plus sealed specimens that had been exposed to water vapour at the same RH for a more extended period.

Figure 1 shows the signal differences for two selected CNTs (M3SL/2.6 and M2COOHSL2) and the control sample NORITOX at two different stages of exposure, after 30 min (blue) and 690 min (red). The figures show the ratio $u(q)=I_{wet}(q)/I_{dry}(q)$, which is determined by the contrast between the adsorbant (carbon) and the adsorbate (water). At intermediate q, where the contrast is defined with respect to the helium density ρ_{He}, $u(q) <1$ and this yields directly the amount of adsorbed molecules in the micropores. At low q the effective density of the carbon $\rho < \rho_{He}$ owing to the large scale porous nature of the carbon, and the ratio u(q) becomes greater then unity. In the WAXS region u(q) again becomes greater than unity because the assumption of electron density contrast in a continuous medium breaks down and the adsorbed molecules become directly visible.

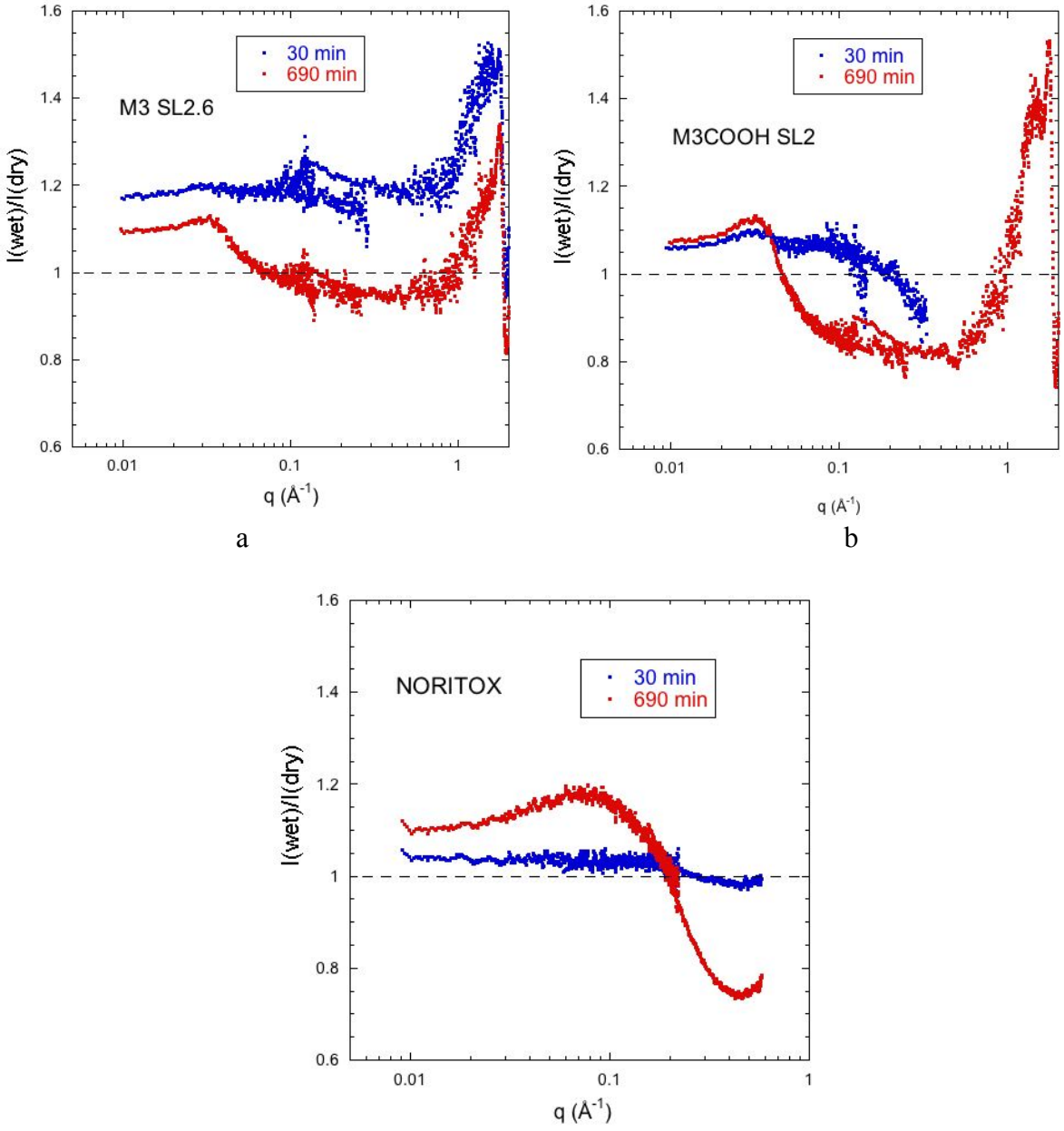

Figure 1. Difference of the scattering signal of CNTs and an activated carbon
a) M3SL 2.6, b) M3 SL2 oxidised and c) (NORITOX)