Low Dimensional Materials and Catalysts

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Carbon nanocontainers and nanoreactors

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Carbon, being a light element with half-full outer electronic shell, is capable of forming atomically thin, yet mechanically robust structures, such as graphene and single-walled nanotubes (SWNT). In our research, we utilise these nanostructures as containers/substrates for individual molecules and atoms. Because of the low atomic number of carbon (Z = 6), SWNT and graphene are particularly suitable for high resolution transmission electron microscopy (HRTEM) analysis as their contrast is sufficiently low to "see though" them and to visualise individual molecules with atomic resolution. Furthermore, SWNT and graphene are very efficient heat and electric conductors, while the chemical reactivity of graphene surface and the interior of carbon nanotubes is extremely low, which protect the structural and the chemical integrity of the molecules during HRTEM studies.

Over the past few years we have discovered, described and formulated fundamental rules governing packing [1], orientation [2,3], and van der Waals interactions [4] of molecules in nanotubes using low voltage HRTEM methodology. More recently, in collaboration with Prof. Ute Kaiser's group at the University of Ulm, we have extended this methodology to aberration corrected HRTEM (AC-HRTEM). This approach has been fruitful for unravelling complex chemical transformations in real-time and direct-space, such as formation of metal clusters [5], structural transformations in nanotube sidewalls [6], spontaneous self-assembly of graphene nanoribbons [7], and transformation of graphene to fullerene [8]. The latter study is particularly significant as it solves a long-standing mystery of the fullerene formation mechanism.

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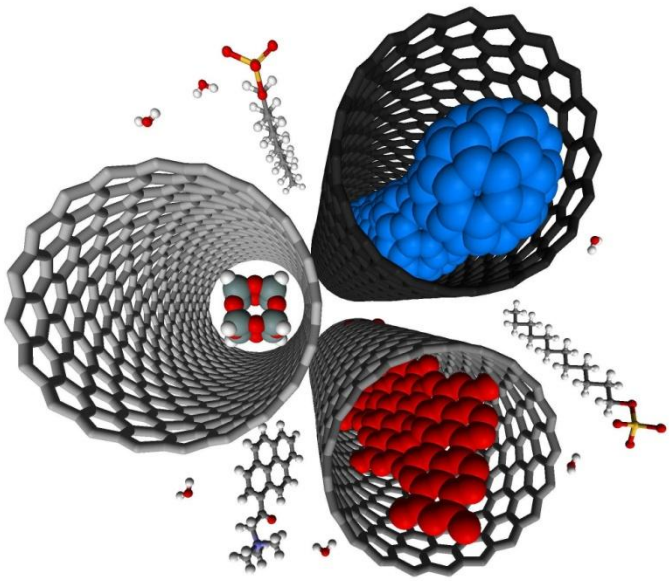

Figure 1. Carbon nanotube serves as a nanoscale bridge between the world of molecules and the macroscopic world.