Ultrathin gold nanowires: growth mechanism and self-assembly

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Ultrathin gold nanowires (NWs), exhibiting a diameter of 1.7 nm and a micrometric length, have attracted expanding interests due to their unique properties, as high surface-to-volume ratio, mechanical flexibility and remarkable conductivity properties, with applications for electrical sensors or transparent electrodes [1,2]. Their very small diameter, very high aspect ratio (>1000) and the great importance of the ligand shell organization both on their growth and stability make these fascinating objects intermediates between metal and 1D supramolecular organization (Fig. 1).

The synthesis is a simple reduction of HAuCl₄ in a solution of oleylamine in hexane at room temperature facilitating in situ measurements [3]. NW growth and self-assembly into hexagonal arrays were followed by in situ small angle X-ray scattering (Fig. 2). The growth rate was found to strongly depend on the solvent. The lattice parameter of the hexagonal phase and the interwire distance varied in the range 9-10 nm and 7.3-8.3 nm, respectively, showing that a bi-layer of oleylamine coats the wires during the growth [4]. We showed also that the interwire distance could be monitored in the range 2.5-8.3 nm thanks to ligand exchange at the wire surface [5]. The atomic structure of the gold core of the ultrathin NWs is still under debate. An fcc structure with stacking faults was reported by HRTEM studies but the Au NWs faced a strong instability and a recrystallization process under the electron beam was observed [6]. Recent in situ WAXS measurements and PDF analysis revealed a non-compact structure. Several structural models are under investigation to fit the PDF patterns that could shed new light on the growth mechanism and the electronic properties.

References


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