Design of coaxial nanowires for enhanced and remote Raman effects

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We designed coaxial nanowires that can support surface plasmon polariton (SPP) with localized surface plasmon resonance (LSPR) to get enhanced Raman spectroscopy in a remote geometry. This original approach paves the way for exploiting single nanowires as remote nanosensors of Raman-active or photoluminescent species. Another promising topic is the use of these single nanowires as sub-wavelength nanosources.

These coaxial nanowires consist in a plasmonic gold core and a conjugated polymer shell of poly(3,4-ethylenedioxythiophene) (PEDOT) as a Raman scatterer, referred as Au@PEDOT nanowires. Figure 1(a) summarizes the whole synthesis process. The fabrication process is based on a templated electrochemical synthesis, using anodic aluminum oxide nanoporous membranes (AAO) as template. Their pore size imposes the diameter of the nanowire Au core. The coaxial geometry was achieved by widening the pores after the synthesis of the gold cylindrical core. Depending on the etching time and process, it was possible to obtain an empty space surrounding the gold core only at the upper part, or along the whole gold cylinder. This empty space was then filled by electropolymerization of the 3,4-ethylenedioxythiophene monomer. The two kinds of resulting nanostructures are schematized in Figure 1(a) A simple process promotes the dispersion of the nanowires in water or ethanol, and then their easy transfer onto any kind of surface.

Our process makes possible to control the diameter of the gold cylinder (between 20 and 200 nm), the thickness of the polymeric PEDOT shell and its location (at one tip, all along, or only at the two extremities for special conditions). These nanowires have been extensively characterized by SEM, HR-TEM and Raman spectroscopy to validate their morphology and to propose a comprehensive growth mechanism.

First results on the design of the opposite architecture, PEDOT@Au nanowires will be reported, where the propagating SPP along the Au nanotube are expected to strongly interact with the polymer located inside the tube and result in exotic behaviours.

![Figure 1: a) Scheme of the hard-template process developed to fabricate the coaxial and the asymmetric Au(core)@PEDOT(shell) nanowires. b) Scanning transmission electron microscopy images of an Au@PEDOT nanowire. (b1) Higher magnification image of an area of the same nanowire and (b2) energy electron-loss spectroscopy is used as elemental analysis of the same area. Sulfur appears in green and carbon in red.](image)

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