Silver nanowires with optimized silica coating as versatile plasmonic resonators

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Metal nanowires feature several advantages for applications. [1, 2] Their elongation offers a larger interaction volume, their resonances can reach higher quality factors, and their mode structure provides better coupling into integrated hybrid dielectric-plasmonic circuits. [3] It is crucial though, to control the distance of the wire to a supporting substrate, to another metal layer or to active materials with sub-nanometer precision. A dielectric coating can be utilized for distance control, but it must not degrade the plasmonic properties. Amorphous silica has been proven an excellent candidate for coating nanostructures, as it is optically transparent, chemically inert and photo-chemically stable. It is also perfectly suited for both emitter-hosting and distance control. So far, coating of the silver nanowires with an amorphous silica shell have been prepared via the Stöber method. [4] In a typical procedure, the encapsulation by a silica shell involves the hydrolysis of tetraethyl orthosilicate (TEOS) and subsequent formation of silica surrounding the silver nanowires. Normally, the hydrolysis of TEOS is performed under an alkaline environment served by ammonia solution in the literature. However, in the reported approaches, the silver is likely to be affected by the used ammonia solution. [5] Herein, we introduce a novel approach based on a modified Stöber method that improves on these shortcomings for higher quality of the coated silver wires as well of the silica shells, which are well-defined in terms of thickness, homogeneity and especially in surface roughness as compared to reports in literature. We use transmission electron microscopy, dark-field microscopy and electron-energy loss spectroscopy to study morphology and plasmonic resonances of individual nanowires and quantify the influence of the silica coating, showing that the coating does not deteriorate the plasmonic properties and thus introduce silver nanowires as usable building blocks for integrated hybrid plasmonic systems. [6]

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