Deposition of Electronic and Plasmonic Materials inside Microstructured Optical Fibres

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Abstract

Optical fibres are the transport medium of today's digital information. However, current telecommunications fibre systems require external solid state circuits to generate, amplify, receive, and manipulate the light. The fusion of the two technologies, namely fibre photonics and semiconductor electronics is expected to have a major impact on next generation of optoelectronic devices, exploiting both the guiding capabilities of optical fibres and the processing properties of semiconductors devices. Only recently, with the advent of microstructured optical fibres and templating material processing methods, it has been possible to create optical fibres with solid-state material inclusions.

Our group has developed various high-pressure chemical vapour deposition (HP-CVD) methods for the formation of extreme aspect ratio tubes and wires of semiconductors, metals and other functional materials within the capillary holes of microstructured optical fibres (Fig. 1). Fabrication of composite structures in this way provides optical fibres with a number of new electronic, photonic and plasmonic degrees of freedom [1, 2].

TEM, SEM and micro-Raman analysis was used to determine the structural characteristics of silicon and germanium-modified microstructured optical fibres. These studies demonstrate that single crystal, poly-crystalline and amorphous semiconductors can be conformally deposited within the capillary voids of microstructured optical fibres. As a step towards fibre-integrated optoelectronic devices, it is demonstrated that in-fibre silicon and germanium wires and tubes can function as field effect transistors and light waveguides.

Figure 1. SEM micrographs of polycrystalline semiconductors deposition by the HP-CVD method within micro sized MOFs. a) Unfilled silica honeycomb fibre template, scale bar is 2 μm. b) Fibre template after silicon deposition, the scale bar is 2 μm. c) Germanium modified fibre, scale bar is 5 μm. d) silicon wires etched out of the MOF template, scale bar is 20 μm.

References

1) P.J.A. Sazio et al. “Microstructured Optical Fibers as High-Pressure Microfluidic Reactors” Science 311, 1583 (2006)