Composite Material Hollow Core Fibers – functionalisation with silicon and 2D materials

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Abstract:
Hollow Core Anti-resonant fibers allow for guidance of mid-infrared light at low attenuation and allows for a variety of applications, such as high powered laser transmission and gas-based sensing to be achieved. Recent work has seen the integration of silicon [1] into such fibers with linear losses with the potential to be as low as 0.1dB/m. Due to the change in refractive index difference of silicon via for example the free carrier plasma dispersion effect, the prospect of an all optical modulator using such a fiber has been proposed [1]. Here, further work has been undertaken on the integration of functional materials inside hollow core fibers via the deposition of the TMD semiconductor material MoS_2, in its few-layered form. Through the use of a liquid precursor, a high quality MoS_2 film can be deposited over 30cm length of fiber, as confirmed via Raman spectroscopy. The transmission spectra of these novel composite material hollow core fibers has also been analysed, showing additional loss of around 5bB/m, despite being only around 2nm in thickness. This implies that the refractive index of the integrated material is potentially able to modify the guidance properties of the fiber sample. We will present a comparison of the composite material hollow core fibers we have fabricated to date and discuss the prospects for using these novel waveguides in the active manipulation of light, including optical switching, sensing and frequency generation.

[1] W. Belardi *et al.* Optics Letters **42 (13)** 2535 (2017)

Summary:

Air-glass negative curvature anti-resonant hollow core fibers (NC-ARF) can exhibit low loss guidance properties over a broad wavelength range. We present here a new concept in the design of such waveguides in which thin layers of functional materials such as silicon and 2D transition metal dichalcogenides can be deposited within the hollow-core and cladding regions to create composite-material anti-resonant fiber designs (CM-ARF). We show that the addition of the few layered material has little detrimental effect on the overall linear transmission loss of the fiber, thus allowing for the exploration of “active” hollow core waveguide device concepts.