Nanostructuring of glass micro/nanowires

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In the past decade, glass fiber tapers with micron or sub-micron diameter have attracted much attention and found a wide range of applications in optics [1] including mode filtering, supercontinuum generation, high-Q resonators and resonant sensing, optical trapping and optical propulsion. Nanofabrication can add new application opportunities, like Fabry-Perot resonators, Scanning near-field optical microscopy (SNOM) probe and surface plasmon resonators.

In this talk, two types of nanostructured glass micro/nanofibers and their application for light confinement to sub-wavelength dimensions are presented.

The first device exploits plasmons excited at optical fiber tips to obtain high transmissivity, and confine light in two dimensions. Glass fiber tips were nanostructured to achieve the plasmonic resonance condition and then coated by a layer of gold; an extremely small aperture was then opened at the tip apex by focused ion beam (FIB). In this structure, large transmissivity enhancement ($\sim 10^{-2}$) was achieved and effective 2D confinement to 10nm or smaller can be envisaged by decreasing the aperture size. This tip can be integrated into optical systems and used for SNOM, optical data storage and photolithography.

The second class of devices achieved 3D light confinement by carving a phase-shifted Bragg grating (PSBG) cavity in microfiber using FIB. Since in microfibers light is radially confined by the glass/air interface, for appropriate taper diameters the diffraction limit can be achieved. Longitudinally, confinement is provided by the phase shift in the center of PSBG. In this structure, the large refractive index contrast between glass and air requires only dozens of periods to achieve a strong grating. Light confinement to sub μm^3 can be envisaged. Applications range from sensing to triggered single-photon sources and the measurement of Casmir effect.

References

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