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Nanosources and wave-guiding in polymer-based nanowires and nanotubes

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Besides inorganic semiconducting and dielectric nanowires, the study of π-conjugated and hybrid 1D-nanostructures is a fastly growing domain of research because of the great versatility offered by their architectures at the scale of the characteristic physical lengths. Novel nano-architectures give opportunities to control the optoelectronic properties, that could result in new paradigms for devices, such as nano-sources for tagging, sensing and lasing. Moreover, the 1D geometry promotes sub-wavelength optical propagation and cavity effects suitable for integrated nanophotonic devices (for a review, see [1]). Here, the color control in coaxial hybrid nanowires and the visible light propagation in polymeric nanotubes are reported, as well as nanosources combined within a single nanowire waveguide.

In the first study, we propose an alternative strategy to get bright nano-emitters whose spectral emission can be precisely and simply anticipated. It consists in minimizing the role of charge and energy transfer mechanisms between the two species, in contrast to the common donor-acceptor strategy. In a practical way, the first key point is the selection of two luminophores with no overlapping in their absorption and emission spectral range. The second key point is the spatial separation of the two types of luminophores in a coaxial geometry to prevent charge and energy transfer. [2] For nanowires fabricated by a template strategy, this was achieved by first depositing nanotubes of a π-conjugated green polymer with a solvent-assisted method. Then, the nanotubes were filled with a PMMA-red emitter composite. It has been shown that this strategy promotes a simple and fine tuning of the photoluminescence features with both species in similar concentration. These advantages could make our strategy a new paradigm for nano-emitters.

In the second study, the propagation of light in the visible range along polymeric nanotubes has been investigated. The case of nanotubes is of particular interest because only few studies are reported in the literature and it permits higher interactions between the propagating light and both the surrounding medium and the inner channel, highly suited for nanosensors. The light was directly injected within nanotubes of SU-8 photoresist (a standard in integrated microdevices). The attenuation coefficient estimated by a cut-back like method has typical values of about 10 dB/cm. Simulation by FDTD has shown that most of the losses are due to leakages through the SiO_2 substrate. [3] Thus, such polymeric nanowires and nanotubes are very competitive structures as sub-wavelength waveguides. Recent developments focused on combining fluorescent conjugated molecules within passive polymeric nanotubes will also be reported.

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