Light-emitting polymer nanofibers doped by organic and biological chromophores: morphology, waveguiding properties, and energy transfer

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Light-emitting micro- and nanostructures and smart materials based on electrospun fibers are being widely studied and they can find use in the realization of lasers, light-emitting diodes, field-effect transistors, photovoltaic cells, optical sensors and many more [1, 2]. Thanks to their anisotropic geometry, light-emitting fibers have features not achievable in macroscopic scale. In particular, they can produce polarized light-emission, but also amplify self-emitted light signal and guide it along the longitudinal axis of the fibers [2]. The success of such materials is supported by electrospinning, a one-step, simple and low-cost technique that allows flexible and versatile micro- and nanofibers to be realized through the stretching of a polymeric solution by means of an assisted electrical field [3].
A simple method to produce light-emitting fibers consists in electrospinning inert polymers doped by organic chromophores. Generally, small fluorescent molecules are cheap and efficient in providing lasing emission, and they are suitable to realize light-emitting advanced systems with color tunability, especially when used as pairs for Förster Resonant Energy Transfer. In this respect, organic chromophores can be present in aggregated emissive forms and lead to a wide range of tunability [4]. Luminescent proteins [5] can be also processed and embedded into fibers designed to exploit their emissive properties. These molecules were successfully embedded in core-shell fibers by coaxial electrospinning technologies, realizing a suitable micro-environment for preserving their bio-optical functions [6, 7]. Here we present and discuss processing parameters, physical properties and potential applications of light-emitting nanofibers based on small organic dyes and luminescent proteins. The morphology, sub-wavelength guiding of light, as well as energy transfer phenomena are carefully analyzed. Perspectives in the fields of miniaturized optical sensors and organic lasers are especially promising, due to the interplay of waveguiding and emission properties of the hybrid electrospun nanomaterials.
The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP/2007–2013)/ERC Grant Agreement n. 306357 (ERC Starting Grant "NANO-JETS").

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