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NANO MICRO

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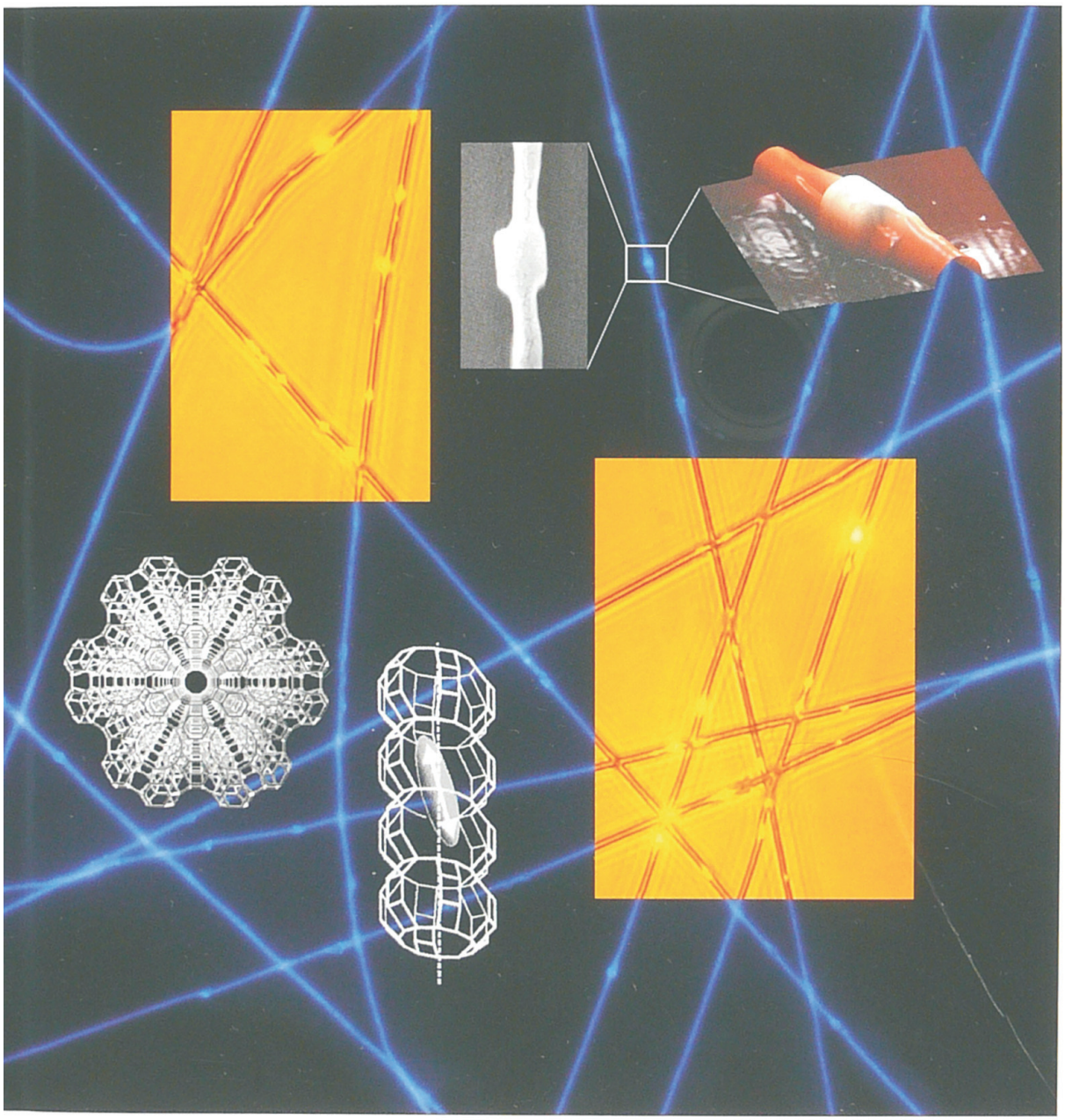



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## 2/2007

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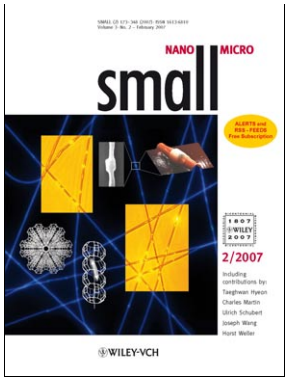
## Cover picture

**Ilaria Cucchi, Fabrice Spano, Umberto Giovanella, Marinella Catellani, Alessio Varesano, Gion Calzaferri, Chiara Botta***




The cover picture shows composite nanofibers obtained by electrospinning a polymer doped with a blue-light-emitting dye, containing fluorescent zeolite L crystals. Even in small-diameter (150 nm) nanowires, zeolites of about 600–800 nm in diameter and 1 μm in length are well embedded into the fibers, with their crystal axis parallel to the fiber axis. Since zeolite L crystals impose a specific orientation on the organic dyes inserted into their parallel nanochannels, the reported procedure provides a simple method to hierarchically organize an ensemble of emissive molecules. Dye-loaded zeolites, integrated into fluorescent nanowires, form very bright nanometric light sources emitting polarized light in the visible region of the spectrum that can be exploited in advanced nanophotonic applications. For more information, please read the Communication, “Fluorescent Electrospun Nanofibers Embedding Dye-Loaded Zeolite Crystals” by C. Botta and co-workers on page 305.

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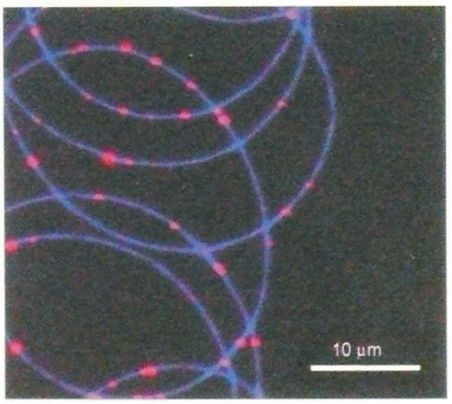


**Zeolite crystals are embedded** in nanofibers (see image) electrospun from dye-doped polymer solutions containing the highly fluorescent zeolite L crystals. Dye-loaded zeolites, integrated into nanowires with diameters in the range of 150 to 600 nm, are well oriented along the fiber axis, forming very bright nanometric light sources with visible polarized emission, which can be exploited in advanced nanodevices. This procedure provides a simple method to hierarchically organize an ensemble of emissive molecules.

## Embedded nanocrystals

Embedded nanocrystals

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# Fluorescent Electrospun Nanofibers Embedding Dye-Loaded Zeolite Crystals**

*Ilaria Cucchi, Fabrice Spano, Umberto Giovanella, Marinella Catellani, Alessio Varesano, Gion Calzaferri, and Chiara Botta**

In recent years, host–guest systems have raised much interest due to their very high emission efficiency and chemical stability that make them ideal systems for artificial antennae and color converters. Their properties derive from the fact that the host crystal imposes a specific spatial and geometrical organization to the emissive guest molecules, protecting them against photodegradation. Zeolite L crystals are inorganic hosts that are able to insert organic dyes into their parallel nanochannels, and to impose a specific orientation that depends on the size of the guest molecules.[1] In these crystals, a large amount of emissive molecules are organized in such a way that the aggregation, inducing quenching effects, is avoided even at very high dye concentration. A further organization of the zeolite crystals at a macroscopic level offers the intriguing possibility to orient ensembles of emissive molecules through a hierarchical organization process. Zeolite organization has been pursued by the growth of ordered arrays of crystals onto aligned polyurethane films,[2] while seeded-growth procedures allow zeolite structures to form membranes for organic vapor separation.[3] Previously reported is the organization of dye-loaded zeolites on a substrate by preparing monolayers of oriented and densely packed crystals of which the nanochannels are well aligned perpendicularly to the substrate,[4] and by obtaining two-dimensional hexagonal networks of crystals on elastomeric stamps via surface-tension driven processes.[5] Zeolite embedding and organization into polymeric systems are relevant in exploiting their highly emissive properties in materials for optoelectronic devices.

This Communication reports on the organization of zeolite L crystals into nanometric polymer fibers obtained by an electrospinning technique. We show that zeolites approximately 600–800 nm in diameter and 1 μm in length are well embedded into polymer fibers even when the wire diameter is down to 150 nm. The zeolite crystals are well oriented in the polymer wires with their crystal axis parallel to the fiber axis. Dye-loaded zeolites, integrated into nanowires, form very bright nanometric light sources emitting polarized light at visible wavelengths, which can be exploited in advanced nanophotonic applications.

Electrospinning is a simple and efficient process for the fabrication of long fibers with diameters on both the micro- and nanoscale.[6] The process uses a high-voltage electric field to spin polymer melt or polymer solution into fibers or nanotubes, which can be collected as oriented wires or on a fibrous mat.[7] Electrospinning can produce polymeric nanofibers for numerous applications ranging from membranes and tissue engineering[8] to composite materials,[9] sensors and electronics,[10] photovoltaics,[11] and photonics.[12] Technology for spinning specialized yarns with enhanced properties is receiving more and more interest in the field of intelligent fabrics. In this regard, the well-known use of inorganic fillers (such as $TiO_2$ or zeolites) in the fabric industry could be employed for advanced technologies such as wearable electronics and photonics. Highly responsive fluorescent optical sensors have recently been reported by using electrospun polymer membranes containing a fluorophore.[13] Electrospinning has also been used for the preparation of polymer-hybrid composites by adding filler materials to the polymer solution, such as carbon nanotubes[14] or emissive semiconducting quantum dots.[15] The control of the spatial orientation of the electrospun fibers[16] opens the path to new devices with increased performance (such as field-effect transistors[17]) and to a new class of optoelectronic devices, based on a single fiber of active material.

Here, we report on the preparation of composite nanowires, emitting in the blue and the green regions of the spectrum, which embed dye-loaded zeolites emitting in the green and red regions. Nanofibers of poly(ethylene oxide) (PEO) doped with dithieno[3,2-b:2′3′]-thiophene-S,S dioxide (DTT) emitting in the blue region (FB) were prepared from chloroform solution and show diameters of about 300–800 nm. PEO nanowires doped with pyronine (Py) emitting in the green region (FG) were obtained from aqueous solution, with diameters of 150–300 nm. PEO is a polymer widely used for the fabrication of light-emitting electrochemical cells, organic batteries, and supercapacitors.[18] Zeolites of about 600 nm in diameter and 1 μm in length were loaded with Py and oxonine (Ox) in order to yield bright nanometric crystals emitting in the green (ZG) and in the red (ZR) regions, respectively.[19]

The optical properties of the three dyes are shown in Figure 1. DTT displays a broad photoluminescence (PL)

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Supporting information for this article is available on the WWW under http://www.small-journal.com or from the author.