Nanosources shine on demand thanks to a deterministic control of the local density of states

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Abstract

Porous periodic multilayers have demonstrated their potential in several fields, from photovoltaics[1] to sensing,[2] representing an ideal platform for large-scale devices. When applications dealing with light emission are considered, knowledge on how the local density of states (LDOS) is distributed within the multilayers is mandatory[3] in order to realize a judicious design which maximizes light matter interaction.

Using a combination of spin and dip-casting deposition techniques we report a detail study of how dyed polystyrene nanospheres (d=30nm) constitute an effective LDOS probe to study its distribution within nanostructured photonic media.[4]

This full solution process approach allows covering large areas with photonic coatings of outstanding optical quality. Further it permits incorporation of nanospheres with a diameter of 25 nm at well defined positions within nanostructured multilayers (Fig. 1a). In this manner we have placed a monolayer of such emitters at several positions of the structured sample (Fig. 1b). A combined use of photoluminescence (PL) spectroscopy and time resolved measurements are used to optically characterize the multilayers. While the former shows how depending on the probe position its PL intensity can be enhanced or suppressed, the latter allows to probe the LDOS changes within the sample, monitored via changes in its lifetime. We demonstrate how information on the local photonic environment can be retrieved with a spatial resolution of 30 nm (provided by the probe size) and relative changes in the decay rates as small as ca. 1% (Fig. 1c), evidencing the possibility of exerting a fine deterministic control on the photonic surroundings of an emitter.

References

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Figures

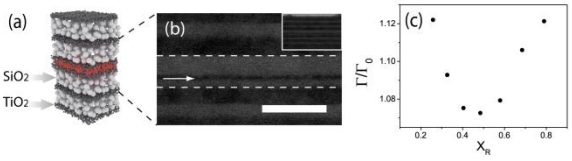

Fig. 1. (a) Diagram of the fabricated samples. **(b)** SEM images obtained with backscattered electrons of a sample with a monolayer of spheres. **(c)** Evolution of the decay rate of the dye doped spheres (normalized to a reference sample) as their position is changed across the resonator.