Optical properties of dyes confined into carbon and boron nitride nanotubes

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The inner cavity of nanotubes has been used as a template for the encapsulation of elongated dyes molecules, such as polythiophenes (6T). The 1D confinement of the nanotube wall drives the stacking of the molecules and induces original aggregation effects in their optical properties [1,2]. When confined inside a carbon nanotube, the organics dyes exhibit for instance a surprisingly strong Raman signal clear of its luminescence emission due to an efficiently quenching effect from the nanotube [3]. Here we show that boron nitride nanotubes (E_g~5 eV) having inner diameters between 1 nm to 5 nm provide similar 1D confinement effects with the difference that they preserve the luminescence of the dyes. The resulting 1D nanohybrids (dye@BNNT) shows in photoluminescence imaging experiments strong and tunable luminescence emissions depending on the dyes used. Experiments on individual dyes@BNNT demonstrate that the BNNT protect the dyes against oxidation and reduce significantly the dyes photobleaching under continuous photo-excitation. Preliminary results on *Daphnia Pulex* colored with dyes@BNNT suggest that these dye@BNNT nanoprobes have reduced toxicity for multimodal imaging based on Raman and luminescence and that they can be adapted to work in the NIR I window to study biological materials.

[1] E. Gaufrès *et al* Nature Photon. **8**, 72-78 (2014)
[2] S. Cambré *et al* Nature Nano. **10**, 248-252 (2015)
[3] E. Gaufrès *et al* ACS Nano, **10**, 11 (2016)