Whispering gallery mode lasing in supraparticles of luminescent nanocrystals

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Semiconductor nanocrystals (NCs) have recently attracted a lot of interest in the scientific community due to their unique size-dependent optical properties: NCs show very sharp photoluminescence emission due to quantum confinement of the exciton in all three dimensions. Thanks to the confinement, NCs show a much higher density of states at the band edge and their emission profile is concentrated in a much narrower spectral region compared to the corresponding bulk material. All these properties make NC quantum dots promising for lasing applications. In some cases, NCs have already shown lower lasing thresholds compared to corresponding bulk gain media [1]. Similarly, NCs can be absorbed onto the surface of silica spheres, which act in this case as ring resonators, obtaining coherent lasing from whispering gallery modes [2].

Here we show coherent whispering gallery mode lasing from spherical supraparticles (SPs), composed of luminescent NCs. The supraparticles are formed through an oil-in-water micro emulsion synthesis [3] and they have a size that can be adjusted between few hundreds of nanometers to some micrometers. Due to the large difference in refractive index of the supraparticles with air, they confine the electromagnetic light modes and act as optical cavities themselves. Whispering gallery modes have been observed in these systems [4], but we show for the first time coherent lasing from a single SP. The sharp lasing peaks in the blue end of the spectrum are associated with the emission from the core and from the shell of the NCs [Fig.1].

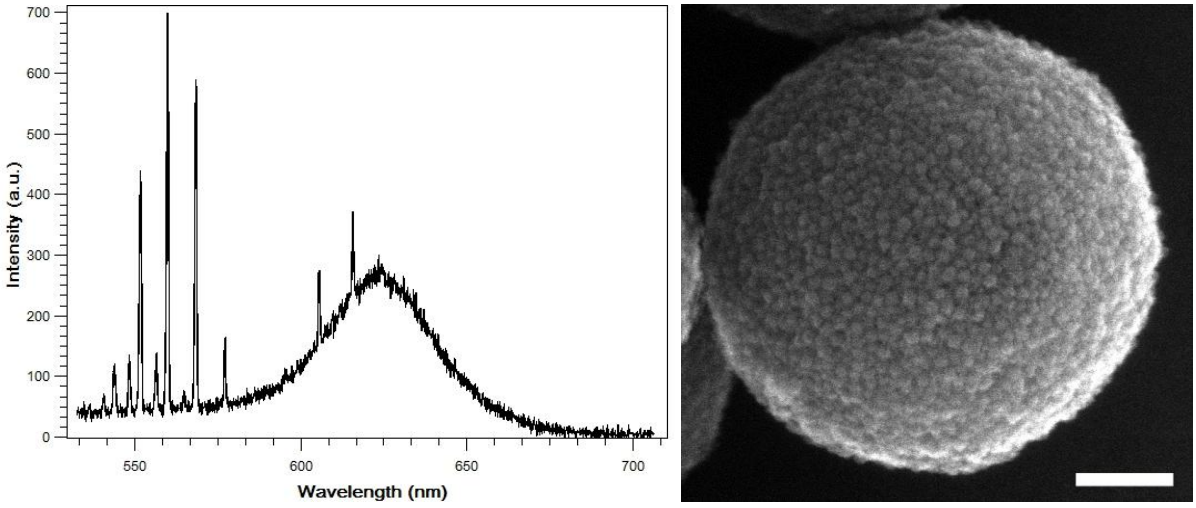

Fig. 1 Left) Emission spectrum of a single SP in lasing regime; Right) SE-STEM of a SP (scalebar 100 nm).

[1] V.I. Klimov *et al*., *Science*, **2000**, *290*, 5490, pp. 314-317.
[2] S. Yakunin et al., *Nat. Comm.*, **2015**, 6, 8056
[3] de Nijs et al., *Nat. Mat.*, **2015**,14, pp 56-60
[4] Vanmaekelbergh et al., *ACS Nano*, **2015**, 9 (4), pp. 3942–3950.