Energy transfer in QD dendrite-type fractal superstructures

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The unique luminescent properties of colloidal quantum dots (QDs), tunable via precise control of their size, shape and composition, allow for a broad range of applications including energy harvesting. Self-assembly and Langmuir–Blodgett fabrication of QDs into superstructures ranging from layer-by-layer configurations with a pre-determined band-gap progression, to fractal clusters, dendrites and nanowires, constitute powerful approaches to engineering systems with directed energy flow via exciton transport without charge transfer. Furthermore, interactions between elements within these structures can lead to new interesting properties of the superstructure.

Here we present the investigation of excitonic energy transfer in self-assembled dendrite-type fractal-dimension structures (DFST) composed of (nominally) monosize CdTe QDs by mapping their fluorescence spectra and lifetimes. Our results indicate the Förster-type energy transfer in these superstructures, caused by the near-field (non-radiative) dipole-dipole coupling between the individual QDs within a dendrite. The measured emission lifetime is higher in the central (and denser) part of the dendrite. The experimental findings were supported by theoretical modeling results obtained by using master equations for exciton migration/decay kinetics in diffusion-limited fractal aggregates composed of identical particles [1]. We find that the fractal geometry of the dendrite, with the QD density decreasing from its core towards the periphery, leads to the energy concentration in the core. The asymmetry between the inward and outward exciton fluxes leads to the more intense and longer lived emission from the central part of the dendrite structure.

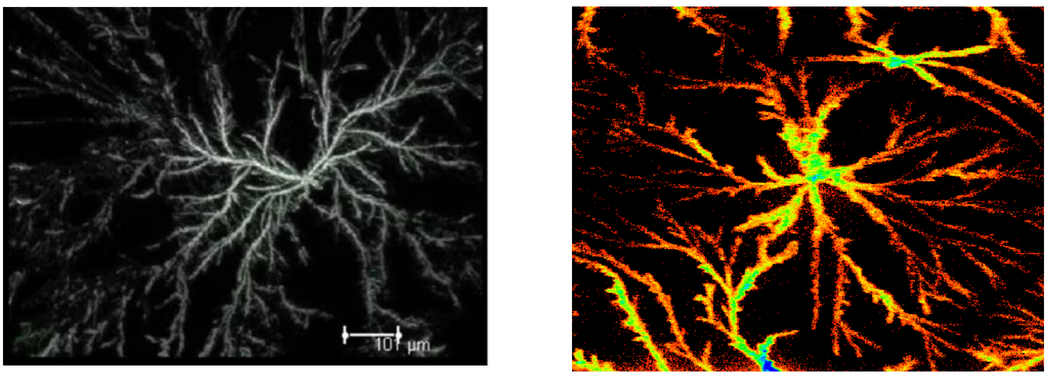

Figure1. (left) Microscopy image of DFST; **(right)** Lifetime map four representative DFST.

Keywords: Self-assembly; Energy transfer; QDs dentrite-type fractal structures.

[1] C. Bernardo et al., J. Phys. Chem. C, 2014, 118 (9), pp 4982–4990.