Poster

FORMATION AND ELECTRICAL INTERFACING OF NANOCRYSTAL-MOLECULE NANOSTRUCTURES

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Investigation of the opto-electronic properties of single molecules remains a significant challenge, driven both by the scientific vision of wavefunction engineering at the nanometre scale and by the technological vision of molecules as functional building blocks in future nanoelectronic devices, circuits and architectures. However, interfacing individual molecules (~ 1 nm long) using top-down lithography remains a significant challenge. Ligand-stabilised inorganic nanocrystals (~2-30 nm core diameter) represent attractive candidates to bridge the gap between feature sizes routinely available using top-down lithograpy (30-50 nm) and the molecular length scale; see Figure 1. Nanocrystal-molecule assemblies also offer the potential for formation of nanostructures and architectures with novel (opto-) electronic properties arising from the individual characteristics of the nanocrystal and molecular building blocks and also the collective properties of the assembly.

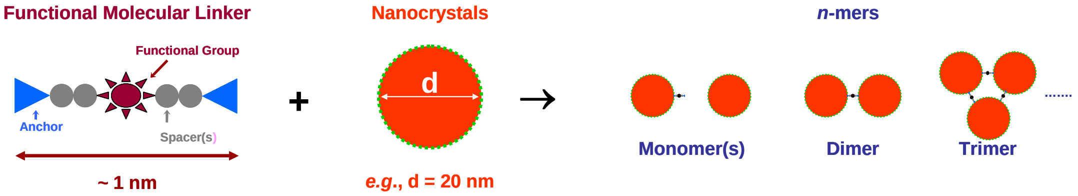

Figure 1. Schematic of solution-based formation of nanocrystal-molecule-nanocrystal *n*-mer nanostructures.

We have recently developed a robust process for formation in solution of nanocrystal-molecule *n*-mer nanostructures using ligand-stabilised size-similar metal nanocrystals with core diameters in the range 10-40 nm and bifunctional organic linkers. UV-Visible spectroscopy of these solutions reveals the evolution of a peak close to 630 nm, see Figure 2a, likely due to formation of dimer nanostructures. Scanning electron microscopy (SEM) measurements of the solution following drop-deposition onto Si substrates indicate formation of dimer and higher-order *n*-mer nanostructures (as well as individual “monomer” nanocrystals); see Figure 2b. Statistical analysis of >400 structures counted in SEM images acquired at random locations yields an *n*-mer distribution with ~ 15% dimers; see Figure 2c. Similar distributions can be reproducibly obtained by monitoring the evolution of the UV-Vis response in real-time. Simulations are currently underway to determine the influence of the dimer and higher order *n*-mer populations on the optical properties of the *n*-mer distribution.

We have also developed dielectrophoretic trapping processes for assembly of nanostructures between top-down fabricated contact electrodes (source-drain separations ~ 30 nm). Initial data for *d* = 20 nm nanocrystals indicate localised trapping of nanocrystal assemblies. Investigations of potential electronic functionality in nanocrystal-molecule *n*-mer structures are in progress.

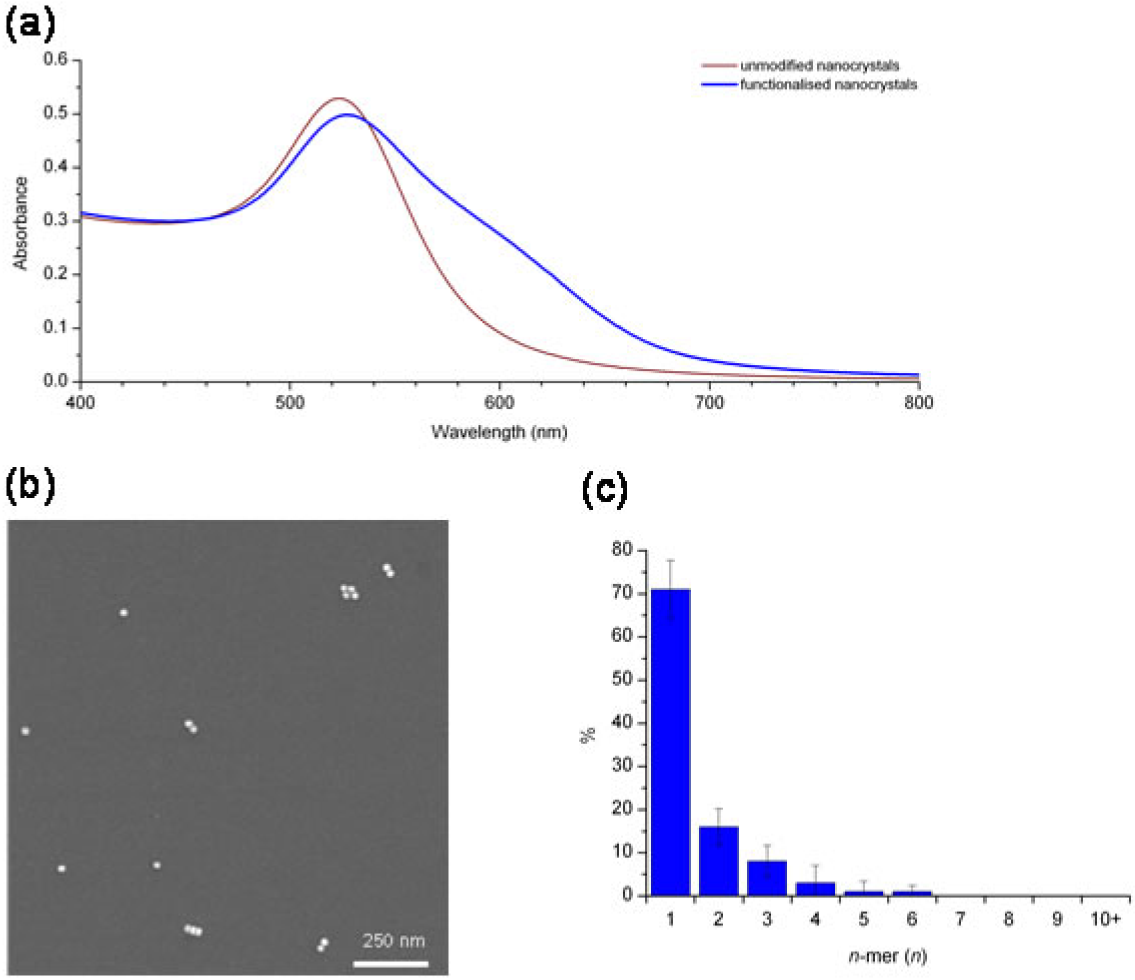

Fig. 2 **(a)** UV-Visible absorbance spectrum of unmodified *d* = 20 nm Au nanocrystals (wine) and nanocrystal-molecule nanostructures formed in solution (blue). **(b)** Typical high-resolution Scanning Electron Microscopy image showing a range of *n*-mer nanostructures**.** **(c)** Histogram showing the distribution of nanostructures corresponding to the UV-Visible absorbance data (blue) acquired in (a).