

Surface Modification of Self-Assembled Semiconductor Quantum Dot Microlasers

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Microlasers self-assembled entirely from colloidal quantum dots (CQDs) have been recently reported [1,2]. Surface functionalisation of such lasers, which has not been shown before, is essential for realising their biosensing potential. Here, we demonstrate an approach for the surface modification of self-assembled microlasers with streptavidin which can act as a platform for further functionalisation or sensing by exploiting the avidin–biotin interaction.

Bottom-up self-assembly of orange-emitting CdSSe/ZnS CQDs was carried out using an oil-in-water emulsion technique [1,2], yielding microspheres with an oleic acid surface that are insoluble in water. A ligand exchange with 3-mercaptopropionic acid (MPA) was carried out [3] to put a carboxylic acid group on the surface of the microspheres for the streptavidin to bind to [4]. Ligand exchange and streptavidin modification was indicated with FTIR and UV-vis measurements. Microsphere size remained between 1 and 20 μm throughout the functionalisation process as measured by optical microscopy. Microspheres were optically pumped with a 355nm, 5ns pulsed Nd:YAG laser at a 10 Hz repetition rate with a beam spot area $2.6 \pm 1.5 \times 10^{-5} \text{ cm}^2$. Oleate- and streptavidin-coated spheres, with diameters of 9.1 μm and 11.5 μm respectively, exhibited lasing with thresholds of 1.9 μJ and 8.7 μJ respectively. Figure 1(a) shows the threshold curve for the streptavidin-capped microsphere and Figure 1(b) shows its emission spectra above and below threshold. Lowering the threshold of the streptavidin coated microspheres to match oleate-coated spheres is required but the fact functionalised spheres can lase is promising for future applications.

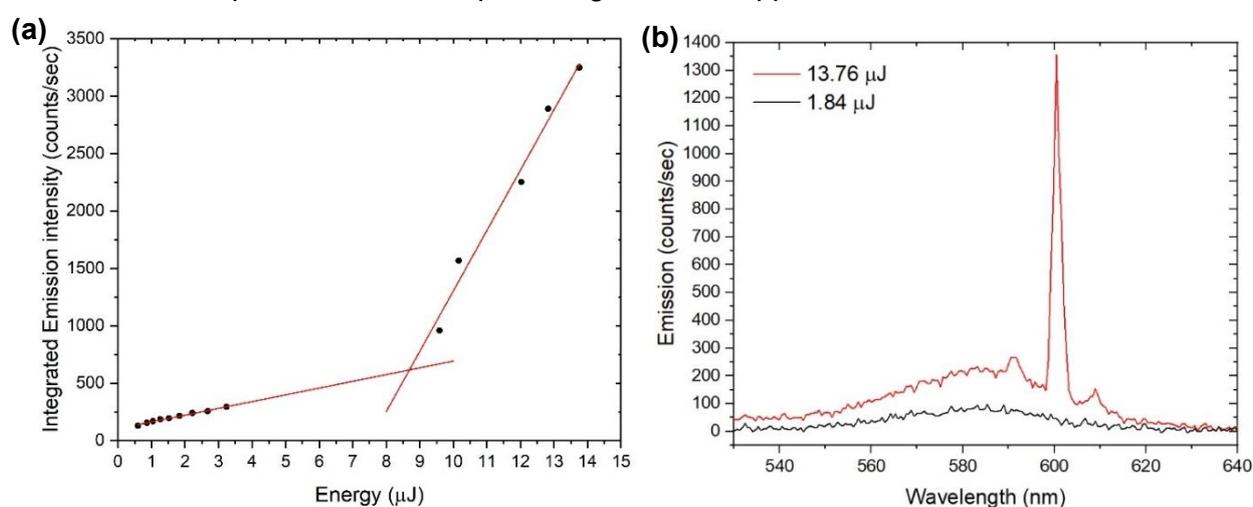


Figure 1 (a) Threshold curve for a streptavidin-coated microsphere; (b) Lasing spectrum of the streptavidin coated microsphere, above and below threshold at 13.76 μJ and 1.84 μJ respectively.

[1] F. Montanarella, et al. ACS Nano, **12**, 12788–12794 (2018)

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[4] M. Stanisavljevic *et al.*, Chromatographia, **76**, 335–343 (2013).