Supplementary Material (ESI) for Chemical Communications

Supplemental Information

Engineering Multifunctional Magnetic-Quantum Dot Barcodes by Flow Focusing

Supratim Giri, Dawei Li, Warren C. W. Chan*

Institute of Biomaterials & Biomedical Engineering & Terrence Donnelly Center for Cellular and Biomolecular Research.
University of Toronto, 160 College Street, 4th floor
Toronto, ON M5S 3G9 (Canada)

Supplemental Method:

Synthesis of quantum dots (QD): ZnS-Capped CdSe QDs were synthesized and characterized according to previously published procedures and stored in chloroform.[1-3]

Synthesis of oleylamine coated Fe_3O_4 magnetic nanoparticles (MNP): Oleylamine coated Fe_3O_4 nanoparticles were prepared following a published procedure[4] with some modifications and characterized by TEM and SQUID measurements In the first step, 530 mg of $Fe(acac)_3$ (Sigma-Aldrich, 99.9%) was dissolved in 7.5 mL of 1-octadecene (Sigma-Aldrich, 90%) and 7.5 mL of oleylamine (Sigma-Aldrich, tech. 70%). The solution was dehydrated at 110 ^oC for 1 h under vacuum. Next, the reaction vessel was filled with argon and quickly heated to 300 ^oC at a heating rate of 20 ^oC/min. The reaction was continued for 1 h at this temperature. After the reaction, the solution was allowed to cool down to room temperature. The Fe_3O_4 nanoparticles were washed with 50 mL of ethanol, followed by centrifugation and later dispersed in chloroform at room temperature for future use.

Synthesis of magnetic-QD barcodes: Barcodes were prepared by mixing TOPO and HDA coated QDs (500 nm and 600 nm) with MNPs (oleylamine coated Fe_3O_4) and the

polymer poly(styrene-co-maleic anhydride) in chloroform. The resulting chloroform solution was then introduced into a nozzle system (Ingeniatrics) using a syringe pump (World precision Instruments) at a rate of 1mL/h along with the focusing fluid water at a flow rate of 180 mL/h set by another syringe pump. The entire nozzle system was then submerged inside a beaker partially filled with water. The polymeric barcoded microbeads were synthesized *in situ* and the beads formed a colloidal suspension in the water. After the synthesis, valve was closed and the beads were hardened by an overnight stirring and then collected. The microbeads were then filtered using 35 μm BD Falcon nylon mesh strainer cap, counted using automated (Beckman Coulter) Vi-cell counter. The relative intensities and the magnetic strengths of the barcoded beads were varied by changing the concentrations of the two different wavelength emitting QDs and the MNP concentrations in chloroform, respectively.

Characterization of the magnetic-QD barcodes: The TEM images of the barcodes were obtained by drying aqueous suspension of barcodes on copper grids and imaging them using 100 kV FEI Tecnai 20 TEM. The two dimensional contour plot was obtained using Becton-Dickson FACS-Calibur flow cytometry system using FL1 (detects 520 +/- 40 nm bandwidth) and FL2 (detects 585 +/- 42 nm bandwidth) filters, and excited using a 480 nm laser. The magnetic measurements were obtained using a superconducting quantum interference device (SQUID) magnetometer at room temperature. The fluorescence spectra of the magnetic-QD beads were measured using a fluorimeter (Fluoromax 3). To obtain the spectra, a constant number of beads were dispersed per unit volume of water and excited at 400 nm in all cases.

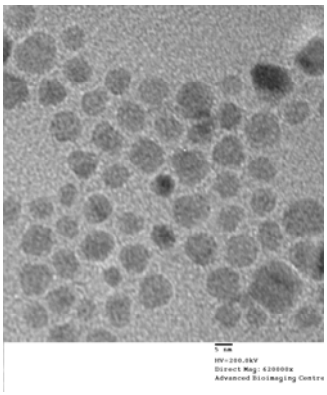

Figure S1. Transmission electron micrograph of oleylamine coated Fe_3O_4 (scale bar is 5.0 nm).

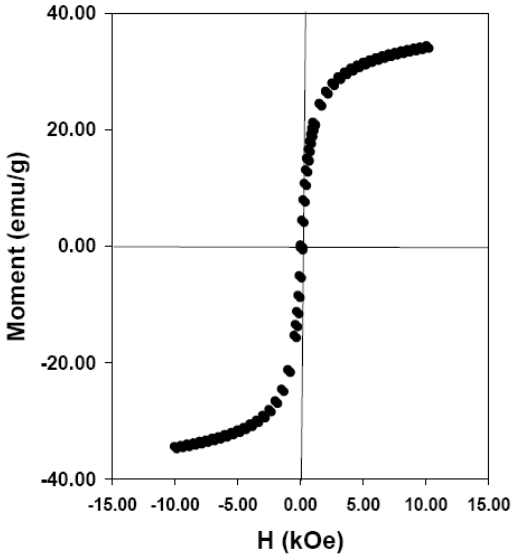

Figure S2. Magnetic moment data of oleylamine coated magnetic (Fe_3O_4) nanoparticles obtained from SQUID measurements.

Table S1. Saturation magnetic moments of the magnetic nanoparticles and the magnetic-QD barcodes.

Material	Saturation magnetic moment (emu/g)[a]
Oleylamine coated Fe_3O_4 MNP	34.4
BM32	15.9
BM16	9.5
BM8	5.6
BM4	3.0
BM2	0.8

[a] Data obtained from superconducting quantum interference device (SQUID) study at room temperature.

Reference:

1. X. Peng, M. C. Schlamp, A. V. Kadavanich and A. P. Alivisatos, *J Am Chem Soc*, 1997, **119**, 7019.
2. M. A. Hines and P. Guyot-Sionnest, *J Phys Chem*, 1996, **100**, 468.
3. B. O. Dabbousi, J. Rodriguez-Viejo, F. V. Mikulec, J. R. Heine, H. Mattoussi, R. Ober, K. F. Jensen and M. G. Bawendi, *J Phys Chem B* 1997, **101**, 9463.
4. Z. Xu, C. Shen, Y. Hou, H. Gao and S. Sun, *Chem. Mater.*, 2009, **21**, 1778.