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Multi-colour Emission from Dye Doped Polymeric Nanotubes by Host-Guest Energy Transfer

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Supplementary information

Synthesis of polymer nanotubes

Solutions of PVK (50 mg/mL) were prepared in $CHCl_3$ by heating to 40 °C under continuous stirring. Similar solutions were prepared with 1 wt. % added dye, i.e., Coumarin 6 or Nile red, (0.5 mg/mL). 50 µL of either a PVK or a dye:PVK solution was drop deposited onto a glass slide. A porous anodized alumina membrane (200 nm nominal pore diameter) was placed on top of the droplet. A weight was applied under ambient conditions to facilitate complete wetting of the alumina pores by the polymer solution. After drying, excess polymer was removed from the membrane using a razor blade. Coumarin 6 or Nile red doped PVK (1 wt. %) nanotubes were also synthesized in this manner using a starter PVK solution that contained added dye molecules at 0.5 mg/mL. Following synthesis, the membrane template was removed by soaking in 6 M aqueous NaOH. Fig. 2 (a) – (c) shows scanning electron microscopy (SEM) images of freestanding arrays of PVK nanotubes and of doped PVK:dye nanotubes, acquired following template dissolution, confirming that forests of close-packed nanotubes could be obtained. To further purify the nanotubes, multiple cycles of centrifugation (9000 rpm, 30 s),, supernatant removal and re-dispersion by agitation were employed to separate discrete tubes from dissolved or particulate template material. Extracted nanotubes were finally dispersed in deionized water by sonication.

Systematic investigation of dye:PVK ratio was carried out in order to select optimum doping level for complete polymer host to dye guest energy transfer. Fig. S1 shows PL spectra of PVK (blue line) and Nile Red:PVK nanotube mats at increasing dye doping levels. It can be clearly seen that a complete quenching of PVK occurs fro dye concentration of 1%. Further increasing of doping levels above 1% did not result in changes of nanotube PL emission. Analogous behaviour was observed in Coumarin 6:PVK doped nanotubes.

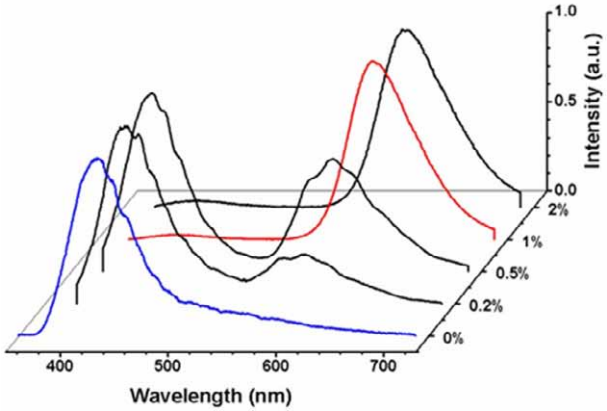

Fig. S1 PL spectra of PVK (blue line) and NR:PVK nanotube mats at respectively 0.2 wt. %, 0.5 wt. %, 1 wt. % and 2 wt. % NR concentrations.

Topographical Characterization of Single Polymer Nanotubes

The topography of individual nanotubes drop-deposited onto glass slides was characterized using a calibrated atomic force microscope (AFM; Dimension 3100, Veeco Instruments Inc.) in tapping mode with commercial tapping mode probes (MP-11100, Veeco Instruments Inc; typical radius of curvature ~ 10 nm and front/side cone angles of 15°/17.5°, respectively).

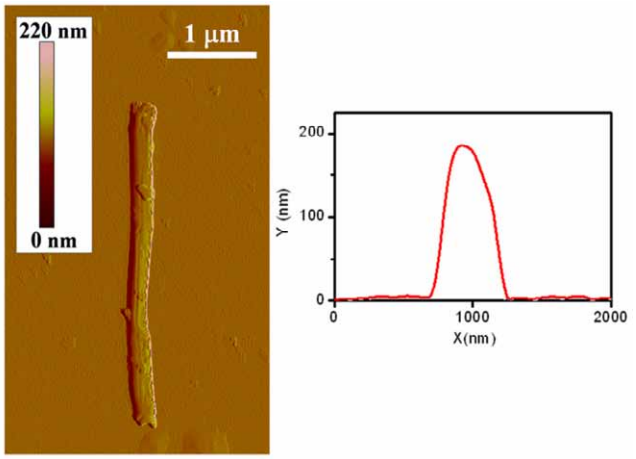

Figure S2 (a) Tapping mode AFM image of a doped C6:PVK nanotube on a glass substrate. (b) Topographical line profile of the tube at the location indicated in (a).