Microencapsulation of Quantum Dots and Organization into Spatial Patterns

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Semiconductor nanocrystalline CdSe particles overcoated with ZnS are synthesized by liquid phase chemistry. The resulting quantum dots (QDs) exhibit a nearly monodisperse size distribution and controlled optical properties as a function of their size due to quantum confinement effects. Polymer microspheres with uniformly embedded polymers have potential applications as active fluorescent building blocks in flat panel displays and luminescent labels in biological detection. The main challenge in the preparation of the QD-microspheres has been to prevent phase separation and aggregation of the QDs within the host polymer, while sustaining the quantum efficiency of the QDs and providing a good size distribution of microspheres. We have developed suspension polymerization approaches to realizing CdSe QD-polystyrene microspheres (Figure 19). The microspheres have a nearly monodisperse size distribution as measured by light scattering. Uniform distribution of QD's within the polymer sphere is observed by STEM and single-microsphere photoluminescence. Further surface derivatization of the QD-microspheres will allow chemical self-assembly onto target substrates.

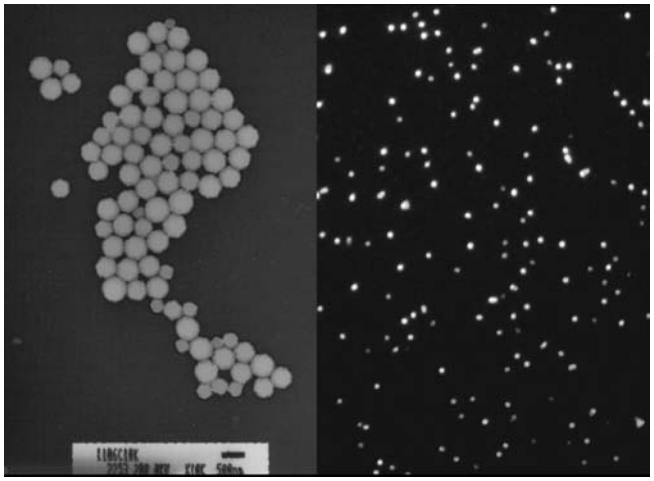

Fig. 19: QD containing polymer microspheres. Left: Electron microscope image (scale bar = 500nm) Right: Fluorescent image of QD-microspheres (mean size 700nm).

We are investigating reactive thin film coatings by Chemical Vapor Deposition (CVD) as a means for realizing spatially controlled patterning of microspheres. As a proof-of-principle, we have deposited poly[*para*-xylylene carboxylic acid pentafluorophenolester-co-*para*-xylylene] and modified the surface ester groups by microcontact printing of biotin-based ligands. The evaluation was done by means of fluorescein-conjugated streptavidin (Figure 20). When combined with surface modified polymer microspheres containing QDs, the reactive coating technique provides new opportunities for developing spatially controlled QD thin film quantum dot structures composites.

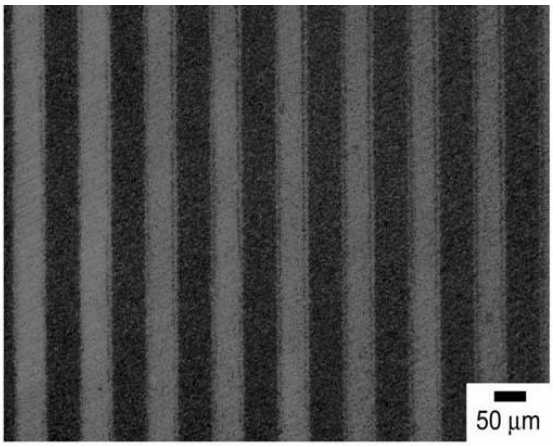

Fig. 20: Fluorescence micrographs of fluorescein-labeled streptavidin bound to the ligand, which was patterned onto the reactive polymer coating by microcontact printing.