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GLASS SURFACE FUNCTIONALIZATION WITH ZnS:Mn QUANTUM DOTS USING POLYELECTROLYTES

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INTRODUCTION: Semiconductor nanoparticles or Quantum Dots (QD) are novel materials with unique physical characteristics caused by the so-called quantum confinement effect [1]. QD have higher photo stability and luminescence intensities than conventional organic fluorophores. Changing the size and composition of QD allows precise control of their absorption and emission spectra. QD applications include biology (biocompatible coatings, biosensors, multicolor labeling), electronics (tunable lasers, flat panel displays, LED) and some other areas. Doping of QD, a recently developed technique, results in increased photoluminescence quantum efficiency and decreased lifetime in comparison with other QD. Here we report on studies to functionalize glass surfaces with Mn-doped ZnS (ZnS:Mn) QD using polyelectrolytes.

METHODS: We used the layer-by-layer technique (LbL) [2] to adsorb nanoparticles from dispersion onto a surface of oppositely charged polyelectrolytes. To this end, clean glass cover slips (7 mm diameter, 0.17 mm thickness) were immersed in an aqueous polyelectrolyte solution of poly(diallyldimethylammonium chloride) (PDDA) or polyethylenimine (PEI) and subsequently in a dispersion of QD. Solutions of polyelectrolyte with concentrations of 0.5% to 5% and QD-dispersions with concentration of 0.07 to 7 mg/ml in 0.01 M NaOH were used. ZnS:Mn QD exhibited a strong optical absorption for wavelengths shorter than 310 nm and an emission maximum at 600 nm. AFM and light microscopy were used for the characterization of QD layers.

RESULTS: Experiments showed that microscopic aggregates of QD (ranging from several micrometers to several hundred micrometers in size) were formed on the glass surface. The size and the density of these aggregates significantly decreased for lower QD concentrations. We found that layers with dispersed QD were formed between aggregates. Figure 1 shows the typical AFM topography image of such QD layer. These layers were not perfectly uniform and contained QD clusters with diameters ranging from several ten to several hundred nanometers. The thickness of the composite polyelectrolyte-QD layer was measured by AFM and found to be several tens of nm.

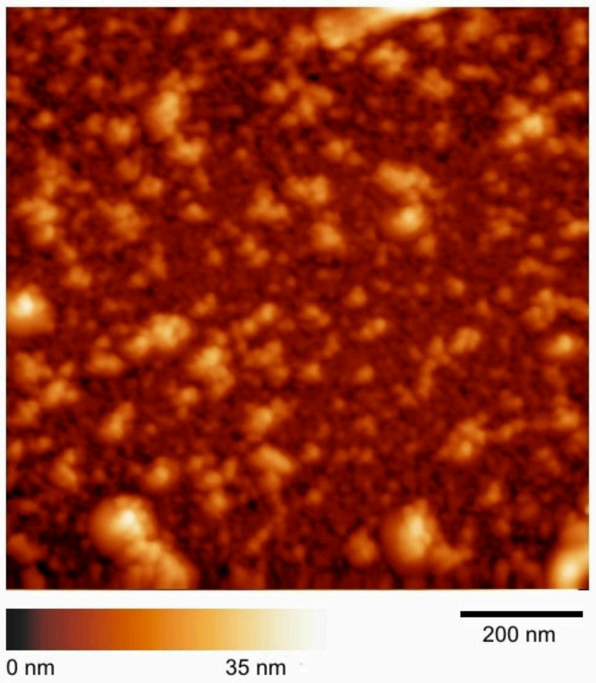

Fig. 1: AFM image of glass surface functionalized with ZnS:Mn QD (0.7 g/ml) on PDDA (0.5 %).

DISCUSSION & CONCLUSIONS: Even though monolayers of single QD (QD size is several nm) were not achieved in these experiments, the topography of the ZnS:Mn QD layers was somewhat intermediate between layers of CdSe QD on PDDA and PEI reported in [3]. Uniformity of layers strongly depends on the combination of QD and polyelectrolyte [4] and on the respective concentrations, which should be fine-tuned later. Choosing different substrates (for example Si wafer [3,4]) may also be considered.

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