Luminescence Encoding of Polymer Microbeads during Polymerization

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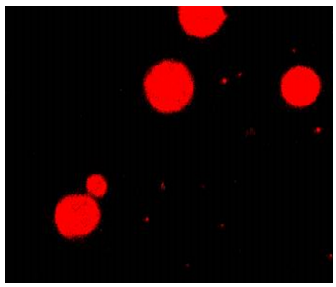
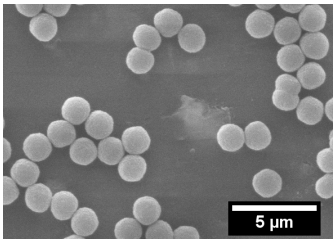
Abstract

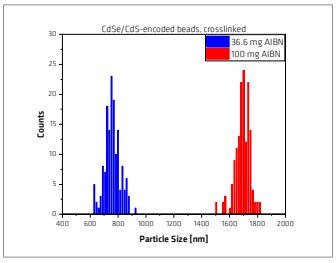
Luminescent polymer microbeads are applied in bead-based platforms for biomolecule binding interactions, and the encoding of these beads is important for the realization of optically distinguishable barcodes. While dye-encoded beads often suffer from photobleaching and spectral crosstalk due to the relatively broad dye emission band, quantum dot (QD)-encoded beads absorb in a very broad wavelength range and reveal narrow emission bands, which enables simultaneous excitation of beads stained with differently colored QDs. To address existing limitations of QD encoding, we have explored simple and effective approaches to homogeneously stain polymer particles and identify suitable polymerization reactions and QD surface ligands that tackle these challenges.



QD-Encoded Polymer Particle Synthesis – Challenges & Solutions



E-SEM image of CdSe/CdS-encoded, crosslinked polymer microparticles.[1-3]



Challenge

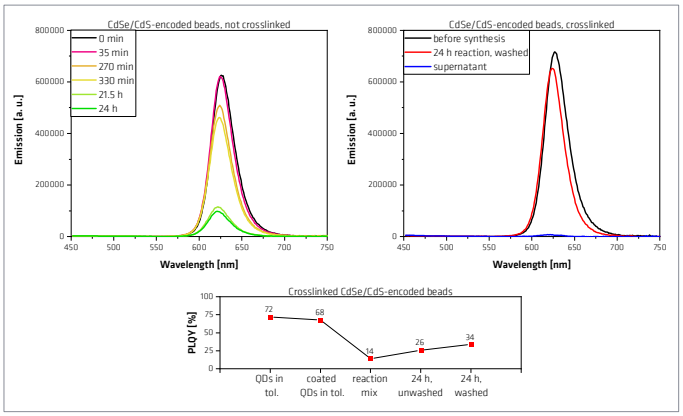
- Aggregation of QDs during synthesis, poor homogeneity of QD distribution in beads
- Broad size distribution of beads
- Loss of QD fluorescence
- QD leaking of encoded beads

Solution

- Coating of QDs with polymerizable ligand
- Addition of copolymer
- Careful adjustment of reaction conditions
- Crosslinking with co-monomer

Influence of Polymerization Conditions on QD Luminescence

The optical properties and photoluminescence quantum yield (PLQY) of CdSe/CdS-QDs and QD-encoded beads were systematically assessed. While coating with a polymerizable ligand does not significantly change these properties, the polymerization reaction leads to a decrease in emission intensity over time, especially for particles not crosslinked. The PLQY is initially reduced in the reaction medium, but increases again once the first encoded beads are formed after 30 min. Then the luminescence intensity decreases gradually over the reaction time of 24 h. However, after several washing steps, it increases again amounting eventually to about the value reached for a reaction time of 30 min. This indicates that the PLQY is not influenced by the polymerization reaction itself, but by the ethanolic environment outside of the monomer/polymer phase.



Results

Differently sized, luminescent, QD-encoded polymer beads have been synthesized with a simple, optimized procedure. The fluorescence properties of the resulting particles have been investigated to ensure sufficient fluorescence and evaluate the influence of the polymerization on the QDs.

References

[1] Acter *et al.*, *Bull. Korean Chem. Soc.*, **2015**, 36, 1467-1473.

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[3] Chen *et al.*, *Nat. Mater.*, **2013**, 12, 445-451.

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