

N-Butylamine surface treatment to decompose ligands and 2D self-assembled controlled connected-nanocrystals arrays

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Introduction

Colloidal quantum dots (QDs) are promising materials for photovoltaic and diode application due to their size-dependent bandgap and full energy spectrum. Herein; we demonstrate a novel strategy to realize inorganic ligand exchange on PbS nanocrystals selectively through ligand decomposition under room temperature without damage to nanocrystals, introduction of S²⁻ to form sulfur-connected PbS QDs enables highly oriented 2D QDs arrays and evenly distributed morphology [1,2]. Finally bromide and Sulfur hybrid-capped QDs realized enhanced carrier mobility significantly measured by Hall Effect.

Experiment

Xanthate molecules binding to (111) facet are decomposed into M-S bonding at room temperature under N-Butylamine (BTA) treatment, CTAB ligand exchange on (100) facet is performed to ensure excellent surface passivation. QDs arrays are connected by interparticles strong chemical Pb-S bonding while quantum confinement is retained (figure 1). Finally CTAB/S capped QDs of electric property and surface morphology of QDs film were checked compared with CTAB-capped QDs film.

Results and discussion

Figure 1 shows the height image, the line-scan profile, the pseudo-three-dimensional image of CTAB-QDs and CTAB/S hybrid-capped QDs under various BTA concentration treatment. Morphology roughness of Rq decreased from 1.41nm to 0.74nm compared with CTAB-capped QDs with Rq=5.72nm significantly. The high images show that Sulfur-connected QDs arrays with highly oriented and densely packed were formed. carrier mobility was shown in figure 2 measured by Hall Effect. Carrier mobility of CTAB/S-QDs film was nearly 7 times higher than CTAB-QDs film due to stronger coupling of adjacent QDs.

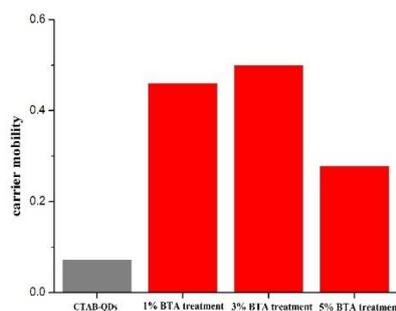


Figure2. Carrier mobility of CTAB-QDs and CTAB/S hybrid-capped QDs under various BTA concentration treatment

- 1) Michael A.Boles & Talapin, *Nature materials.*, 15, 141-153(2016).
- 2) Haitao Zhang & Richard D.Robinson, *Nano.let.*, 2011,11,5356-5361.