Synthesis of high luminescence and stable InP-based colloidal quantum dots in a loose condition

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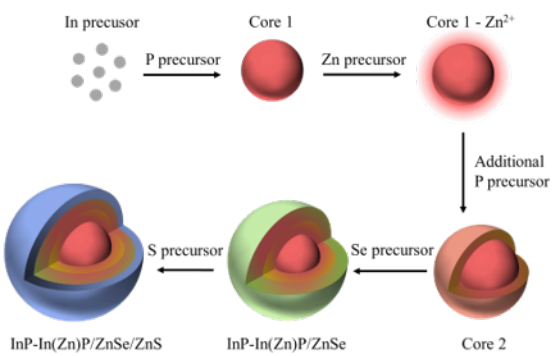
Abstract

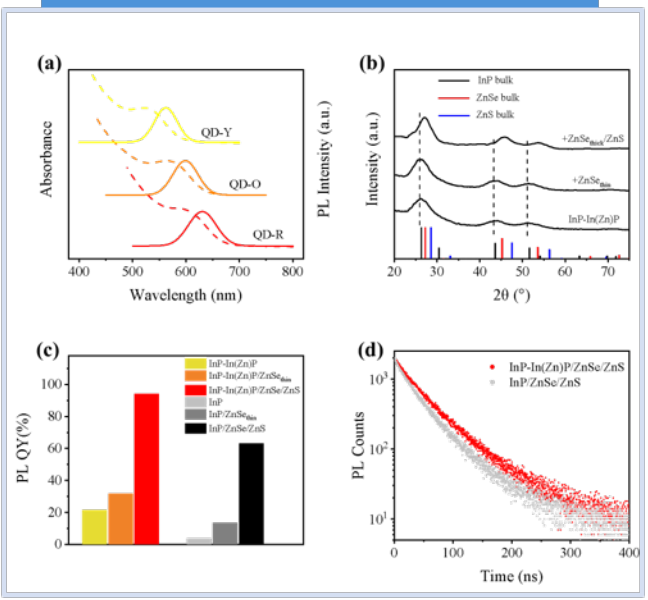
Recently, significant progress has been made in the synthesis of InP QDs: near-unit photoluminescent (PL) quantum yields (QY) have been reported by Jang's group and Peng's group for the core/shell-type InP QDs. However, the repeatability of these methods is poor due to the rigorous synthesis conditions, which limits the commercial application of InP QDs.

Here, we proposed to introduce Zn as substitutional to the out layer of InP QDs. With this strategy, the lattice constant of synthesized InP/In(Zn)P QDs can be tune to 5.76 Å, which is very close to that of ZnSe. The small lattice mismatch promotes epitaxial growth of ZnSe shell onto InP/InZnP cores. Meanwhile, we synthesized QDs with high luminescence properties under a much looser synthesis condition (ultimate vacuum ~ 1000 mTorr) than that in previous studies (ultimate vacuum of 150 mTorr and 1 mTorr, respectively). In this work, InP QDs dots were synthesized by separating the nucleation and growth steps, and then, ZnSe and ZnS were epitaxial grown onto InP/In(Zn)P core in turn after a series of specific steps. With above strategies to control the recombination behaviors of excitons, the resulting QDs achieved the highest PLQY of 94% and excellent chemical stability.

Methods



Results



Conclusions

1. Zn ions were introduced as substitutional during growth pocess to the out layer of InP QDs.
2. The color of the QDs can be tuned from yellow (~570 nm) to red (~635 nm) by controlling the temperature of .nucleation and growth.
3. The PL QY of prepared yellow, orange, and red emmitting QDs were 83%, 90% and 94%, respectively.