Stability and Quantum Mechanical Motion of Multiple Excitons in CdSe Nanoplatelets

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We studied excitons and charge carriers in CdSe nanoplatelets with thickness of a few atomic layers and lateral sizes of tens of nanometers. Excitons and charge carriers were generated by photoexcitation with ultrashort laser pulses and detected by time-resolved optical absorption and terahertz conductivity measurements.[1]

Photoexcitation leads predominantly to formation of excitons rather than free charge carriers. Interestingly, excitons in CdSe nanosheets are stable even at high densities where they start to exhibit spatial overlap. A crossover to an electron-hole plasma of uncorrelated free electrons and holes is not observed. This counter intuitive result can be understood theoretically from the fact that the Coulomb screening length, and thus the exciton binding energy, remain non-zero even at high density.[2,3]

Interestingly, the shape of photoluminescence and absorption spectra depends on the lateral sizes of the nanoplatelets. We found that the dependence of the optical spectra on the lateral sizes is fully explained by taking into account the quantum-confinement effects on the translational motion of excitons in the plane of the nanoplatelets. The spectra can be reproduced very accurately by a theoretical description of exciton energies and oscillator strengths based on the quantum mechanical particle-in-a-box model.[4]

References

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