Measuring the ensemble transition dipole moments of quantum dot films by time and angle resolved luminescence spectroscopy

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The spontaneous emission (SE) of light in semiconductors is due to the excitonic relaxation process and is at the heart of all light emitting devices. The SE rate of light is determined by the transition dipole moment of the system. The transition dipole moment (TDM) magnitude decides the line strength of the SE and the orientation decides the cone of light emission. Here, we outline the measurement of ensemble TDM of alloyed quantum dot (AQD) layers using time and angle resolved luminescence spectroscopy. CdSe-ZnS AQDs are synthesized in hydrophobic phase by one pot hot injection method at 305O C. Then AQDs are assembled into films on glass slides, by Langmuir Schaefer method. The ensemble TDM orientation is measured by using home-built angle resolved spectrometer setup. The magnitude of TDM is extracted from the measured decay profile, by using a WITEC alpha 300 confocal microscope equipped with a Pioquant SPAD system. The appropriate fitting of angle resolved spectral intensity yields orientation of TDM relative to the substrate. The ensemble TDM magnitude of 5 AQD layers is measured to be 1.003 D ± 0.005 D. The orientation of TDM is given by anisotropy parameter (a)=0.349 ± 0.002, agrees well with the value of a=0.333 for an ideal isotropic emitter. The measured TDM data serves as a bench mark for our homebuilt setup. The exciton confinement potential of AQDs is isotropic, so the ensemble TDM of AQDs will be isotropic, which is also reiterated by our measured data.