Fig. 6(b) we show the ratio SPPE/FSE that indicates the difference between the two dynamics. Interestingly, the dynamics of SPPE/FSE is independent of the excitation intensity, implying that the interaction of excitons and biexcitons with the metal surface is identical at the measured emission frequency. It has to be noted here that interactions between excitons/biexcitons and the silver film are not maximized, because the emission frequency is significantly smaller than the SPP resonance frequency of the silver film. Spectral overlap and, therefore, stronger interactions are expected with CdS NCs that emit in the blue and UV wavelength range [28].

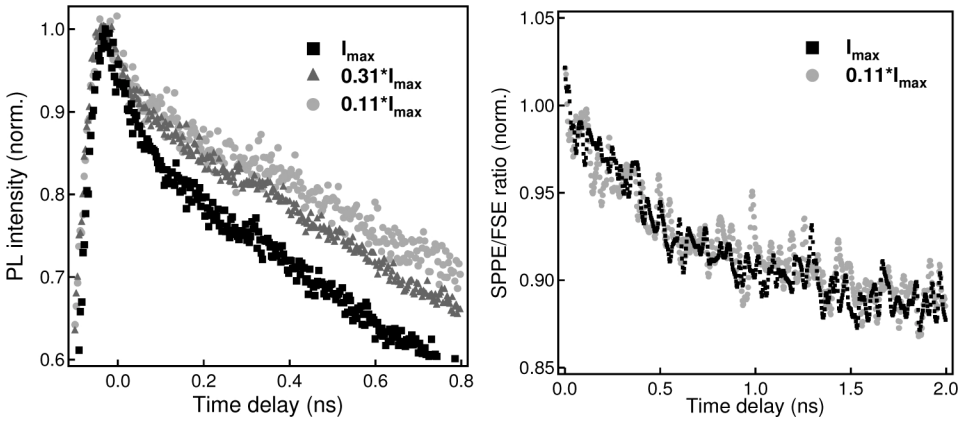

Fig. 6. (a) SPPE dynamics of NCs on a silver film that are excited with varying excitation intensities (emission wavelength is 646 nm). (b) SPPE/FSE ratio at low (grey circles) and high excitation densities (black squares) indicating identical coupling strength of biexcitons and excitons with the silver film.

6. Conclusion

In this work we have studied the interaction of dipole emitters with thin metal films by comparing the decay dynamics of free space and SPP coupled emission. We found that there is a distinct difference in emission dynamics that becomes more pronounced when the dipole emitters are within a few nanometers from the metal surface and when the emission frequency is close to the SPP resonance frequency. Comparing measurements with numerical calculations we concluded that the different dynamics can be assigned to a difference in coupling strength of parallel and perpendicular emission dipoles with lossy surface waves. The same experiments performed at high excitation levels revealed that the interactions of biexcitons and excitons with the metal surface are similar at frequencies that are off resonance with the SPP resonance frequency. The obtained insights into the interactions of emission dipoles with metal surfaces are of fundamental importance for NC-based SPP amplifiers and SPP-based sensors, specifically when used for single molecule detection with well defined dipole orientations.

Acknowledgments

This work was supported by the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation under the grant ECCS-0725609.

#129833 - $15.00USD Received 10 Jun 2010; revised 22 Jun 2010; accepted 23 Jun 2010; published 7 Jul 2010
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