

Probing of Oleic Acid Capped CdSe Quantum Dot Surface Using Visible-Infrared Sum Frequency Generation Spectroscopy: Polarization Dependence, Coupling Effects and Orientational Analysis

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Abstract: Polarization dependence and orientational analysis studies on surface of QDs are carried out as original work here. Selective enhancement of CH₃ stretching vibration modes is observed at resonance wavelengths based on coupling effects.

I. INTRODUCTION

This study employs sum frequency generation spectroscopy (SFG) to investigate the ligand arrangement and interactions on the quantum dot (QD) surface using a simple and common oleic acid (OA) capped CdSe QD system. More research work has been reported in literature studying QD systems in bulk, but limited number on surface studies. Previous studies probing QD surface have considered different QD ligand systems and one polarization combination and their work is focused mainly on ordering of ligands on the QD surface and coupling effects^{1,2}.

II. RESULTS

It is proven that we successfully probe the surface of QDs by comparing the Oleic acid capped QD (OAQD) spectra with the spectra for OA on glass. For the first time, polarization dependence of spectra from a QD system is analyzed and it is found to be dominated with ppp signals which is uncommon to adsorbates on a dielectric interface, but has been observed earlier for metals or electrochemical surfaces³. Basic polarization selection rules corresponding to ssp and ppp polarization combinations are also observed to be still applicable to the QD system. Relative intensities of CH₂ and CH₃ stretches suggest minimum gauche effects

and therefore a higher order in terms of conformation of OA ligands on QDs (~2 nm). Further, double resonance SFG (DR-SFG) is used to investigate the coupling effects of vibrations of ligands and electronic properties of QDs. Enhancement of all vibration modes and more of that for CH₃ stretching modes on resonance wavelengths suggest the possibility of this technique to improve sensitivity and selectivity. This work also demonstrates the efficacy of conventional polarization dependence method for orientational analysis for a QD system despite its nano size dimensions of surface.

III. SUMMARY

Surface of QDs is probed using visible-IR SFG and ppp signals dominate the polarization dependence. OA ligand have an orderly conformation on CdSe QDs (~2 nm). DR-SFG probes coupling effects of vibrations of ligands and electronic properties of QD core. Basic polarization rules are conserved and polarization dependence orientational analysis is applicable for this QD system.

REFERENCES

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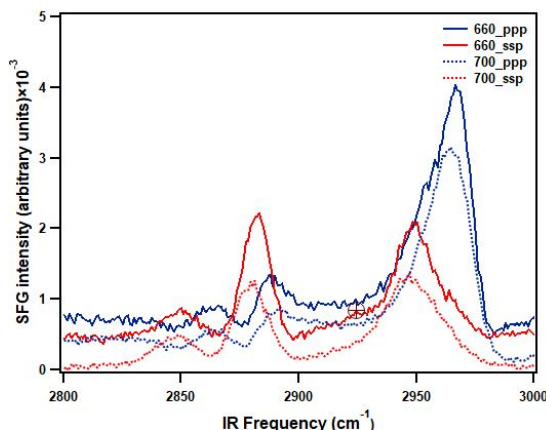


Fig.1. SFG spectra for Oleic acid capped QDs (OAQD) for ssp and ppp polarization combinations at 660 nm visible beam and 700 nm visible beam (on resonance and off resonance).