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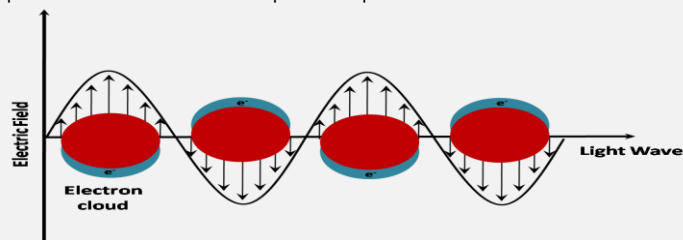
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INTRODUCTION

Recently nanoscience and nanotechnology have sparked a lot of interest in many fields of science and engineering. In the field of plasmonics, noble metal nanoparticles (NPs) exhibit optical properties that differ significantly from those of the bulk. Indeed, they show a strong absorption band in the UV-Vis region due to coherent oscillation of conduction electrons, driven by the electric field of light. This phenomenon is called "Localized Surface Plasmon Resonance" (LSPR) and the position of the resonant peak depends on the size of the metal nanoparticle [1].

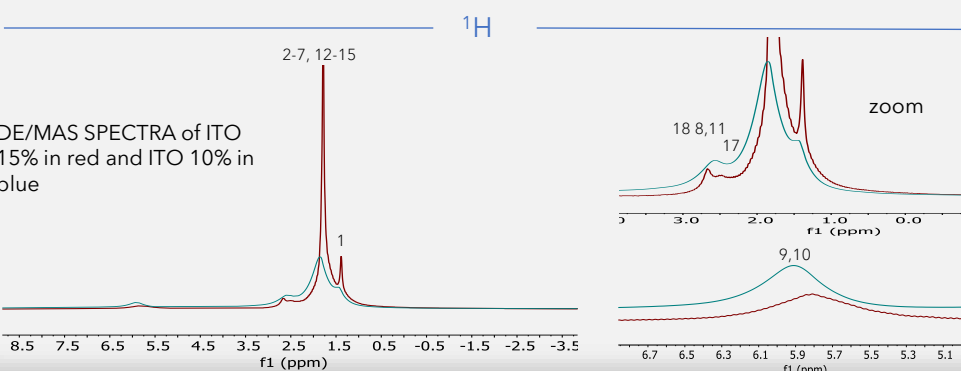
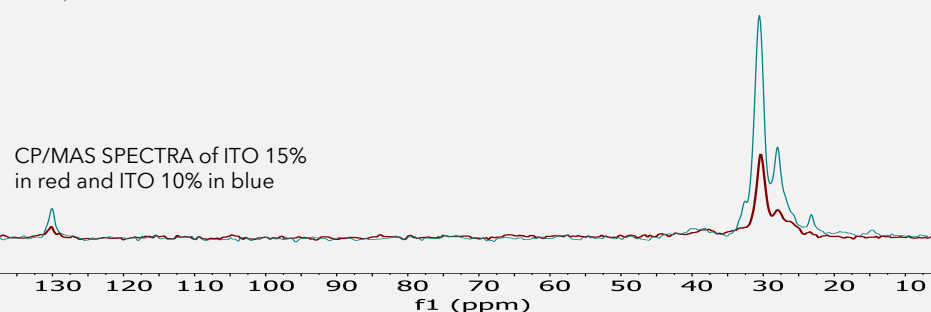
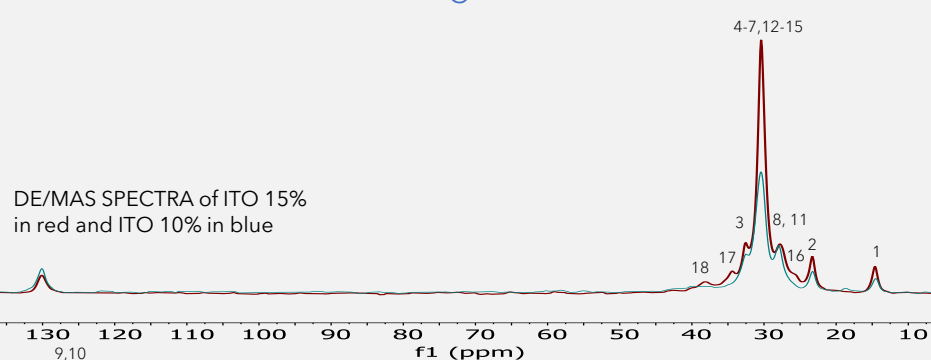
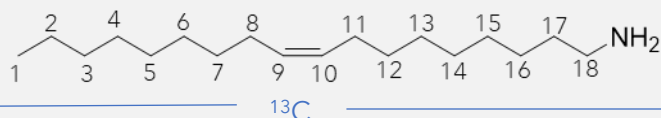


Representation of LSPR for metal NPs

Plasmonic NPs are currently object of considerable interest thanks to their wide range of potential applications in the fields of nano-optics, chemical and biological sensing, spectroscopy and molecular imaging. Lately, doped semiconductors, including tin-doped indium oxide (ITO), have been proposed as new cheaper nanomaterials with plasmonic properties. Unlike noble metal NPs, ITO is a near-infrared plasmonic system and the resonant peak can be easily tuned by changing the dopant concentration [2]. In this work we studied four oleylamine-stabilized ITO NPs samples with different doping concentration (**7.5%, 10%, 12.5% and 15%**) using high-resolution solid state NMR. We recorded ¹¹⁹Sn DE/MAS (Direct Excitation/Magic Angle Spinning) spectra to investigate the effect of doping concentration on the structure and electronic properties. In addition ¹H MAS, ¹³C DE/MAS and CP/MAS (Cross Polarization/Magic Angle Spinning) spectra were recorded in order to get insights into the arrangement and dynamics of the stabilizer around the nanoparticles.

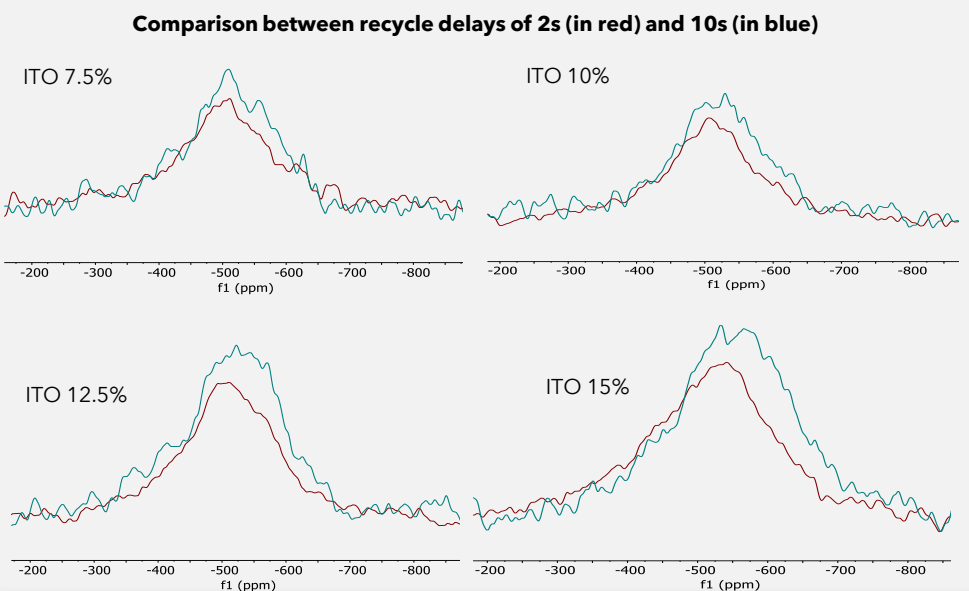
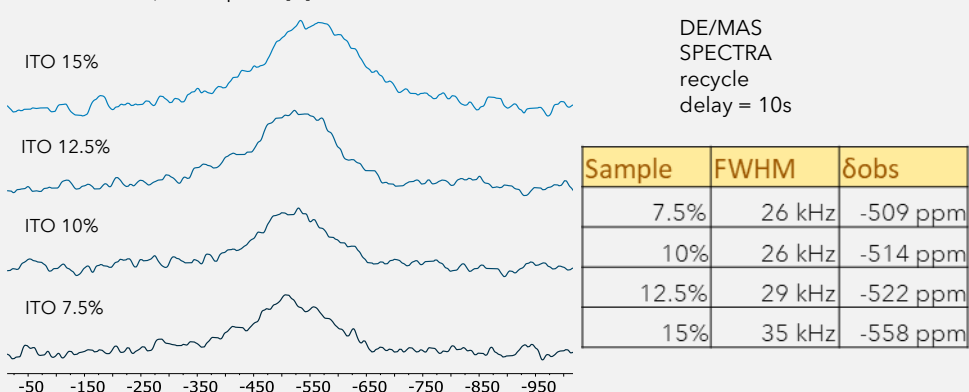
RESULTS

STRUCTURAL CHARACTERIZATION OF OLEYLAMINE



CHARACTERIZATION OF ITO NANOPARTICLES

The incorporation of the dopant is related with the increase of free carriers in the Fermi Level. Indeed ¹¹⁹Sn spectra are influenced by the interaction of free electrons with nuclear spins: this paramagnetic interaction determines the position (δ_{obs}) and the linewidth (FWHM, full width at half maximum) of the peak. [3]



CONCLUSIONS

- ¹³C spectra show that oleylamine chains are mobile and in an amorphous conformation. Moreover, the chemical shift of the methyl group (14.6 ppm) suggests that the oleylamine is in a multilayer environment [4].
- The different linewidths of ¹H and ¹³C signals of the two samples, as well as the different efficiency in the ¹H-¹³C CP experiment, indicates that in the case of ITO 15% the oleylamine is more mobile.
- ¹¹⁹Sn spectra with two different recycle delays (D_1) were recorded. Going from $D_1=2s$ to $D_1=10s$, especially for samples with higher dopant concentration, there is a line broadening and a shift towards lower chemical shift.
- The comparison of ¹¹⁹Sn DE/MAS spectra ($D_1=10s$) shows an increase of ¹¹⁹Sn spin-lattice relaxation time, T_1 , with increasing doping.

EXPERIMENTAL

All the experiments were carried out on a 3-channel Bruker Avance NEO 500 spectrometer using a 2.5 mm CP/MAS probe. ¹³C and ¹¹⁹Sn experiments were performed at a MAS frequency of 15 kHz while ¹H experiments at a MAS frequency of 30 kHz.

CISUP (Centre for Instrument Sharing - University of Pisa) is acknowledged for the use of the Bruker Avance Neo 500 Solid State NMR Spectrometer

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