First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

LOCALIZED SURFACE PLASMONS SHIFTS THE STIMULATION WAVELENGTH OF OPTICALLY STIMULATED LUMINESCENCE DOSIMETERS

ISIKAWA, M. M.[1], ASSUNÇÃO, A.C.A[1], GUIDELLI, E.J. [1]

[1]Departmento de Física, FFCLRP, Universidade de São Paulo, 14040-901, Ribeirao Preto, SP, Brazil, guidelli@usp.br

Introduction: Localized surface plasmon resonance (LSPR) is an optical phenomena generated through electronic oscillations at nanostructured metal surfaces. Optically Stimulated Luminescence (OSL) intensity is enhanced upon interaction with LSP but the exact mechanism is still not clear. In this work, we investigate plasmon-enhanced luminescence mechanisms using the Optically Stimulated Luminescence (OSL) from defect centers in X-ray irradiated sodium chloride nanocrystals deposited on silver nanoparticle (AgNP) films with varying plasmon properties upon blue, green, and red OSL stimulation.

Material and method: AgNP films were produced by a microwave-assisted (MW) method. NaCl crystals were produced over the AgNP films by dropcast. Samples were irradiated in air, using an X-Ray tube (Magnun - Moxtek, USA) operating at 48kVp and 0.2 mA. Optically stimulated luminescence (OSL) was acquired using an OSL reader developed by our research group. Samples were stimulated with blue (470 nm), green (530 nm) and red (652 nm) LEDs.

Results: Figure 1 reveals that the largest enhancements are observed with the red OSL stimulation, when the stimulation wavelength is well tuned with the film plasmon band but not with the NaCl F center absorption (450 nm). Although the absolute OSL intensity for NaCl crystals deposited on glass is higher upon blue stimulation, when deposited on AgNP films and stimulated with wavelengths attending plasmon resonance conditions, higher absolute OSL intensity occurs upon green stimulation and the largest OSL enhancement is observed by employing red stimulation. Therefore, under plasmon resonance conditions, green stimulation could be employed without sensitivity impairment as compared to blue stimulation. These results suggest that, as long as the OSL stimulation wavelength is well tuned with the film plasmon band, plasmonic coupling does not depend on the trap depth and that the greatest luminescence enhancements are achieved in spectral regions where the optical cross-sections of the defect centers are smaller.

Conclusions: Based on these observations we propose that electrons in traps with very small cross-section for light interaction couple to LSPs. This coupling enhances the photoionization cross-section for resonant wavelengths, increasing OSL intensity. For OSL dosimetry applications, this could allow materials to be stimulated with wavelengths farther from the OSL emission window, improving the signal to noise ratio. As a consequence, higher dosimetric sensitivities and more accurate dose assessment could be obtained.

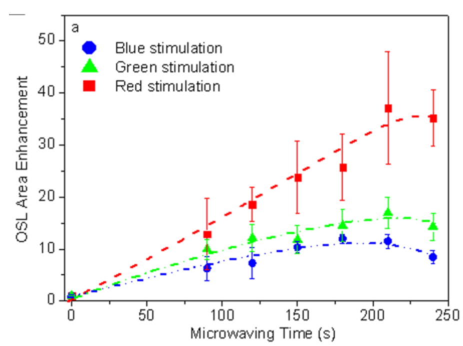

Figure 1: OSL area enhancement from the NaCl crystals on the AgNP films with different MW times and stimulation wavelengths.