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

DEVELOPMENT OF NEW IONIZING RADIATION DETECTORS BASED ON PLASMONIC NANOTECHNOLOGY

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Introduction: Plasmon-enhanced luminescence of luminophores close to noble metal nanoparticles is an important tool for technological development in several areas. However, this amplification only occurs with the appropriate matching of plasmon resonance band with the emission and/or excitation band of luminescent center, making its use limited in areas such as optically stimulated luminescence (OSL) and radioluminescence (RL) dosimetry, because many dosimetric materials do not present absorbs or emit in same region of the plasmonic band of noble metal nanoparticles[1-4]. Our main objective in this study is to produce new dosimetric detectors with tunable plasmon resonance band, as well as characterize the dosimetric and luminescent properties of RL materials under plasmon resonance conditions.

Material and method: Silver nanoparticles (AgNp) films were deposited on a glass substrate (8x8 mm) by a microwave-assited method, with microwaving (MW) times ranging from 90 to 240 s, for the "polyol" method using microwaves. The RL detectors were prepared by depositing $CaF_2:Tb^{+3}$ nanoparticles on the silver nanoparticle films.

Results: The silver nanoparticle films produced with microwaving times above 120 s showed two plasmon resonance bands. The first band peaks at 400 nm. The second band peaks around 600 nm, but shifts to red upon increasing the MW time. It is worth noting that the second plasmon band has a good overlap with the Tb^{+3} emission spectrum, which is required for achieving plasmon enhanced luminescence.

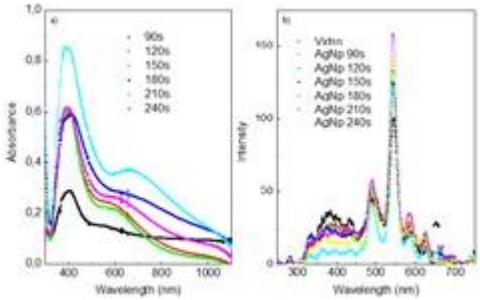

Figure 1: a) Plasmon resonance bands of the AgNp films. b) Radioluminescence spectra of $CaF_2:Tb^{+3}$ nanoparticles deposited on the AgNp films.

The deposition of $CaF_2:Tb^{+3}$ on the silver nanoparticle films showed a considerable increase in the RL signal intensity compared to the intensity obtained when $CaF_2:Tb^{+3}$ was deposited only on the glass, with a maximum enhancement of 36% for the $CaF_2:Tb^{+3}$ deposited on the film produced with 210 s of MW time, compared to the $CaF_2:Tb^{+3}$ deposited on glass.

Conclusions: The radioluminescence intensity of all samples deposited on the AgNp films are higher than the intensity of samples deposited on glass. Furthermore, besides the good matching with the Tb^{+3} emission spectrum, the 210s AgNp film presented the highest intensity of the plasmon resonance band, indicating the plasmonic coupling between the silver nanostructures and $CaF_2:Tb^{+3}$.

References:

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