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Advisor: Dr. Haggeo Desirena Enrriquez

Committee Members:

Dr. Gonzalo Ramirez García
(Secretary - CFATA)

Dra. Tzarara Lopez Luke
(Evaluator - IIM-UMSNH)

Dr. Haggeo Desirena Enrriquez
(Chairperson)

Thesis: "SYNTHESIS AND CHARACTERIZATION OF PHOTOTHERMAL CERAMIC PARTICLES FOR USE IN PRINTED ANTI-COUNTERFEITING APPLICATIONS"

Summary:

Due to the constant evolution of counterfeiting media, it is necessary to improve anti-counterfeiting technology. Hence, the main objective of this research work was the design of security systems based on the PTT effect of materials. For this purpose, Ln^{3+} doped ceramic particles, whose PTT response was optimized, were fabricated in order to be used in real printed applications. In the first approach, Sr/Zr ceramic oxides doped with Yb^{3+} were synthesized.

A photothermal ink was prepared with the Sr/Zr particles. In conjunction with the thermochromatic ink, based on a reversible thermochromatic pigment, a printed security system was designed, fabricated and tested. This was evaluated with multiple NIR wavelengths and under external heat sources and it was determined that only by exciting with the absorption wavelength of the oxides was the photothermal effect generated, which produced the heating of the thermochromatic ink and thus the information was revealed.

For the second approach, $LaBO_3 : Nd^{3+}$ and $LaBO_3 : Yb^{3+}$ particles were fabricated separately, whose photothermal response is more efficient than that of $Sr/Zr : Yb^{3+}$. This effect is selective, i.e. they only responded to a specific and different NIR wavelength from each other. With these, multilayer printed codes were designed, which were only revealed using a thermal camera when excited by he specific wavelengths for each layer. The verification of the code is given with a sequence determined by the order of the layers. To improve the level of security, commercial particles with frequency upconversion were added, so that the verification of the information was performed through both the thermal and the visible imaging channel.

The proposed strategies show potential to be applied in different items, shown as examples medicine packaging, business cards, etc. Moreover, within the scientific character, the synthesized samples show a more efficient photothermal response when compared to lanthanide-doped materials reported in the literature.