Nanostructured Materials for Medical and Biological Applications (CREST – NSF Award Nº 1345156)

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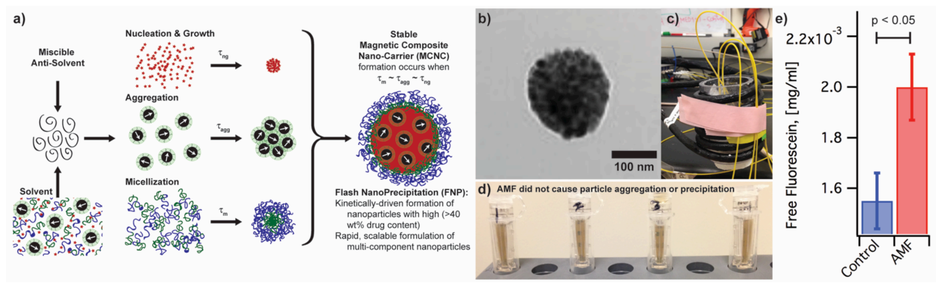
Abstract: This interdisciplinary research group (IRG) of the University of Puerto Rico – Mayagüez (UPRM) Nanotechnology Center seeks to develop new nanoscaled materials for cancer therapy assisted by the application of magnetic fields and specialized light sources. Their toxicity and transport will be assessed using model human cancer cell lines and other appropriate models. The final goal of this IRG is to create non-invasive therapeutics for treatment of patients suffering from diverse forms of cancer.

Optimization of the Thermal Chemopotentiation of Anticancer Drugs by Magnetic Fluid Hyperthermia for Cancer Treatment

Magnetic Nanosystems for Thermal Potentiation and Delivery of Chemotherapeutic Agents

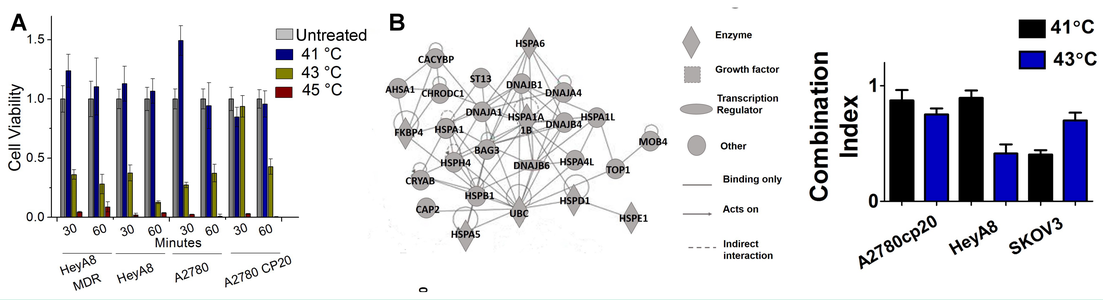
(Eric Fuller, Shijian Wu, Carlos Rinaldi)



We are exploring the use of Flash NanoPrecipitation to generate Magnetic Composite NanoCarrriers (MCNCs) for encapsulation and magnetically triggered release of hydrophobic drug cargos.

Mechanisms of Thermal Resistance

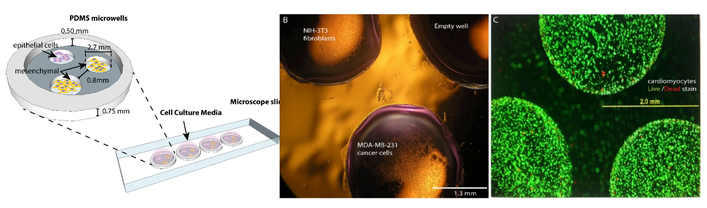
(Karem A. Court, Madeline Torres-Lugo, Carlos Rinaldi, Eduardo Juan)



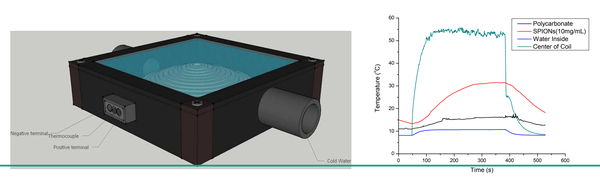
Genomic analysis was employed to determine the underlying causes of thermal resistance and used to produce a therapeutic synergistic effect [1]

Development of Novel Tools for the Investigation of Nanomaterial/Tissue Interactions

(Jorge Castro, Reinaldo Agostini, Karla Ramos, Fernando Boria, Maribella Domenech, Madeline Torres-Lugo Carlos Rinaldi, Eduardo Juan)



Multi microwell culture arrays were developed to understand multicellular interactions [2,3]

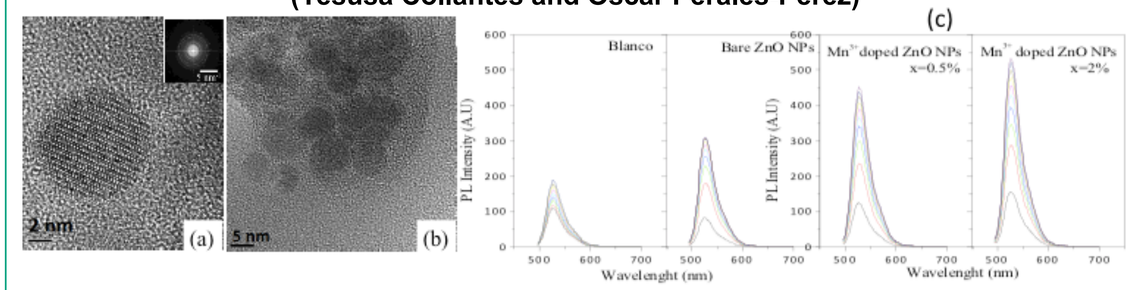


Miniaturized coil prototype for live cell imaging was developed

Toxic Metal-Free Quantum Dots For 2-Photons Photodynamic Therapy for Energy-Driven Cancer Therapy Applications

Pure and Mn-doped ZnO Nanoparticles for 2-Photon Photodynamic Therapy

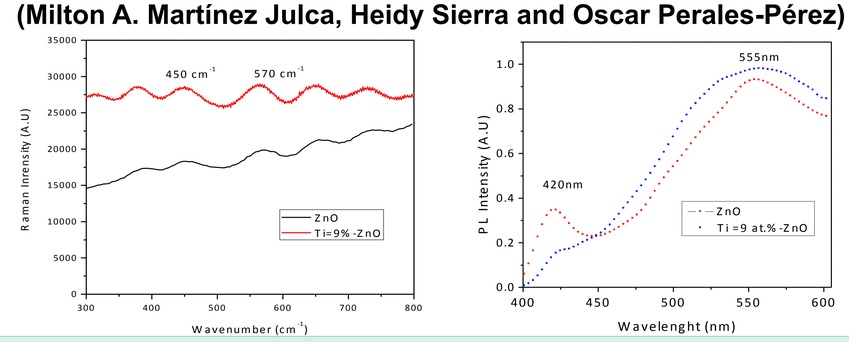
(Yesusa Collantes and Oscar Perales-Perez)



(a, b) HRTEM images of 5nm and 7nm ZnO QDs synthesized by the polyol route; (c) The enhancement of the 525nm emission intensity from the sensor green kit by prolonging UV irradiation times and higher concentrations of Mn^{3+} species (0-2 at%) in ZnO, evidenced the increased generation of cytotoxic SO species. Similar results were attained when Li, V and Ti were used as dopants.

Induced Structural Defects in Ti-doped ZnO and Its 2 Photon-Excitation

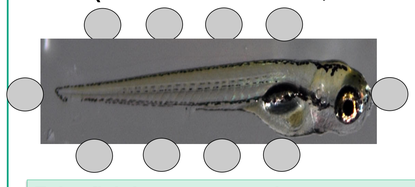
(Milton A. Martínez Julca, Heidy Sierra and Oscar Perales-Pérez)



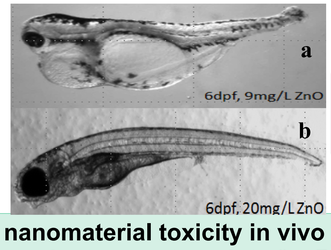
Left: The shift of the main vibrations Raman modes is attributed to the distortion in the lattice caused by the incorporation of Ti species. **Right:** Normalized TPFM (690nm) emission spectra. **The capability of ZnO and Ti-ZnO NPs capacity to be excited by 690 nm light opens new possibilities for light-induced bio-medical applications.**

Zebrafish Testbed in Photodynamic Therapy

(Julio O. Acevedo, Oscar Perales-Perez, Martine Behra and Magda Latorre)



Zebrafish larvae exposed to nanomaterias



Toxic effects of ZnO NPs at high concentrations: (a) edema, (b) necrosis

A zebrafish testbed is used to determine nanomaterial toxicity in vivo in a high throughput manner. This model organism will also be used to evaluate quantum dots for PDT in cancer models.

References:

[1] Court K.A. Rinaldi, C., Juan, E, Torres-Lugo, M., et al, *Mol. Can. Ther.* Submitted 2016

[2] Provisional patent 62/293,836, 2016, M. Domenech

[3] Alvarez-Garcia, Y.R., Ramos, K., Boria, F., Domenech, M., et al. *Lab of a Chip*, Submitted 2016