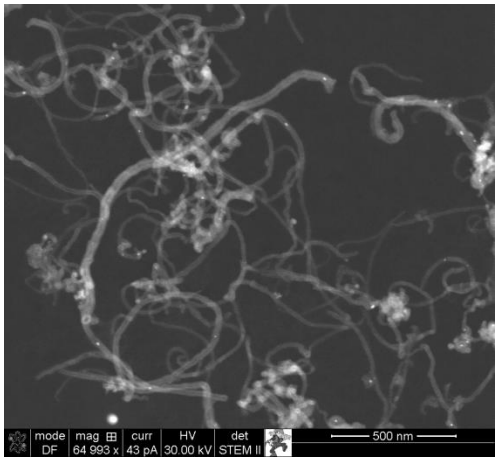
The First Spoils of Battle…

Adapted from redapestudio.com

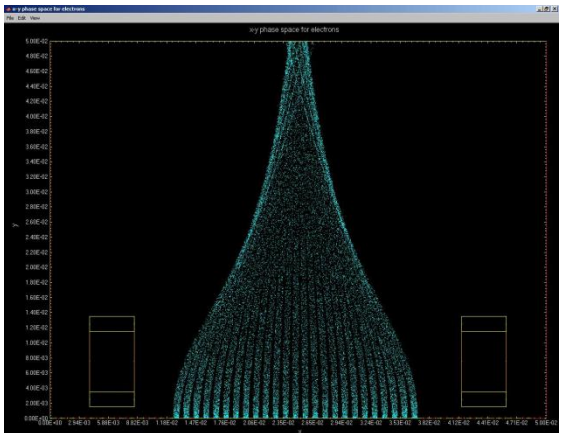
Dr. Castaño's Group Report:

Last year I was telling the Newstron readers that my group was strongly pursuing research dollars. This year I can report on our first successes and our future plans to consolidate our research initiatives. Last year we obtained the first internal grant for $30,000 from the Missouri Research Board. This internal funding source is part of the University of Missouri System whose mission is *"to enhance the long-term quality and quantity of scholarship throughout the University by supporting meritorious research projects".* We received their money to study the hydrogen storage capability of a carbon nanotubes (CNT) material functionalized with gamma radiation, and currently we have functionalized CNTs by chemical means (functionalization = create active sites in the surface of the CNTs). My student Jessika Rojas is actively pursuing this research line.



STEM Picture of Functionalized CNTs

The second piece of good news is that together with Dr. Lee we obtained a second Missouri Research Board grant for $33,000. This second grant's objective is to conduct a simulation of a new type of x-ray radiation source. Current X-ray sources consist of a massive (usually W) cathode that is bombarded by electrons and cooled by water, the interaction of electrons with the heavy atom metals create x-rays that are then harnessed and used for imaging. In our research we intend to create the electrons by field emission, and these will be accelerated against a target a few microns in size. The amount of x-rays generated by such a small target is small, but millions of those micro-targets can be arranged together in the same way that any flat screen (TV, computer, cell phone, etc) produces a lot of light. The x-ray "light" coming out of such device has a flat profile that will allow imaging with higher resolutions while subjecting the patient to lower doses. This is a great idea, coming directly from Dr. Lee's quiver. Chrystian Posada and Edwin Grant are both working on complementary parts of this proposal, by doing simulations with MCNP and OOPIC Pro.



Focusing effect on electrons simulated in OOPIC Pro

The third grant came from NRC and is a Curriculum Development Grant. Starting in 2011 all STEM students in Missouri S&T will have the opportunity to learn about Radiochemistry and Nuclear Forensics. We have received $125,000 dollars to develop a theoretical course in radiochemistry, and by the time you read this piece will have sent a continuation proposal to fund a laboratory in Radiochemisty and Nuclear Forensics. The idea is to provide you with a extra tools in your inventory to make you more attractive to potential employers, including homeland security, national laboratories, and industries related to the nuclear fuel cycle at all levels. Matt Korte a new graduate student with the help of two undergraduate students is working in making our radiochemistry lab a reality. They are putting together lab practices in measuring tracers in water, alpha spectroscopy, and actinide separations. The radiochemistry lab will be located in Fulton 218.

The final grant that will directly benefit my group is a Faculty Development grant from NRC. This grant is 3 year continuing grant for a total of $639,444 that will be used to help Dr. Lee and myself. On my part, this grant will support initiatives in nuclear materials, hydrogen initiatives, and nuclear forensics and radiochemistry.

The first of these projects that is starting soon is a fatigue study on a material highly resistant to radiation damage called Oxide Dispersion Strengthened (ODS) steel. ODS steels have yttrium and titanium oxide particles in the nanometer range dispersed uniformly throughout the matrix. Stainless steel can only take radiation damage of <20 displacements per atom (DPA) before failing by swelling, while ODS steels can take damage in excess of 300 DPA. ODS steels have been around for a long time, but problems with their manufacture and handling (welding, annealing, forging, etc) have not been successfully solved. Our plan is to obtain with a collaborator from Ames Laboratory, state of the art samples of the material and use our S&T labs (Dr. Van Aken) to cause high-cycle fatigue to the materials. Once this is accomplished we plan to take the samples to Argonne National Lab and conduct micro-beam synchrotron radiation studies to analyze the cause of fatigue (crack growth, redistribution of oxide particles, etc).

A final initiative that is unfunded at the moment is the study of a special material with properties between cement and ceramic. We plan to develop this material as a suitable shielding material for spent nuclear fuel storage. The ceramic/cement material can be heavily doped with other substances to improve its nuclear properties. In the case of spent fuel, neutron and gamma shielding, as well as higher thermal conductivity. This job is being conducted with the help of a colleague from the *“Universidad de Antioquia”* currently at UCLA. Jason Pleitt my new graduate student is involved in this effort.

These proposals funded are of course a small sliver of all the proposals submitted. Since last year either by myself or in the company of the other faculty in our department, or in our campus, or in the US we submitted 17 proposals ranging in funding from $14,910 to $1’999,997.

Before closing this piece, I want to introduce my research group, by letting my students briefly describe themselves and what they do. Without their work, there would be no research group and frankly very little would happen at all. It is their sustained work that allows research to happen in Missouri S&T.

Chrystian Posada: I received my degree in Chemical Engineering from the National University of Colombia in 2008. In January 2009 Dr. Castano hired me as his first graduate student and I have been working with him since then. I am currently in the process of finishing my Master degree and starting my PhD. Since I came to Missouri S&T, I have taken part in several project. As a result of that, the modulated mass beam spectrometer located in our lab is fixed and calibrated. I am currently developing a series of Particle in Cell (PIC) simulations for determining the optimal conditions for electron field emission from CNTs field emitters. The preliminary results obtained from this research project have been submitted for presentation at the Medical Imaging 2011 conference of the SPIE and we also expect to showcase our results at the 2010 Memphis BioImaging Symposium, in Memphis, Tennessee. I have had the opportunity of participate in two occasions in the Advanced Test Reactor National Scientific User Facility, in 2009 and 2010. It have been almost two years since my first day in Rolla, and the more time I spend here, the more I realize how great this opportunity is for my personal and professional life. My plan is to work as hard as necessary to accomplish the goals and enjoy as much as possible the experience of being part of the Missouri S&T community.

Jessika Rojas: One of the motivations in our research group has been hydrogen as an alternative source of energy. During this year I have been involved in the project granted by the University of Missouri Research Board. Up until now, chemical treatments have been carried out in order to eliminate metallic catalyst particles. We observed the evolution of the nanostructure using different techniques. This project has also been for me a big gate to learn about different characterization techniques, so I received training in SEM, FIB, Raman spectroscopy and FTIR. Those techniques were used as a tool to analyze the changes in the structure. Our next step on this project is to evaluate the mechanism of functionalization by gamma rays based on the creation of reducing agents from water radiolysis. Aqueous solutions containing carbon nanotubes, palladium chloride and a secondary alcohol will be irradiated with a gamma source of Co-60 in the University of Illinois. Morphology, stability, and hydrogen storage capacity of this nanostructured material will be evaluated.

Matt Korte: I am a first year graduate student from Saint Joseph, MO who became interested in nuclear energy for its economic and strategic potential. This Summer, I investigated the possibility of combining tritium and ultracapacitors to make high energy density batteries. I'm currently working with Blake Bohn and Rob Zedric to develop radiochemistry experiments.

Jason Pleitt: I'm a new graduate student from Warrenville, IL. I recently graduated from the nuclear program here at MS&T this past spring before entering the graduate program. I had met Dr. Castano as his first undergraduate advisee and I am currently working on measuring linear attenuation coefficients at different energies for a special ceramic/cement for shielding purposes. I've developed the basic design for the measurement and am working on making sure that the values can be accurately determined at several energies. I look forward to working more on this project in the coming year.

Blake Bohn: I'm from jackson Missouri, I transfered in form a small college to S&T for nuclear engineering. Normaly I spend most of my time in rolla doing homework or Research. It can get very busy but I like learning about nuclear technology so it's very enjoyable. In my free time I like to shoot firearms, go caving, float down rivers, hiking, and collecting common radioactive materials/isotopes. My first nuclear class at Missouri S&T was NE105. That's where I meet Dr. Castano. He was looking for research assistants for radiochemistry. I didn't have much experience and knew I needed to learn more so I volunteered. I found out the later that I would be helping set up a radiochemistry and nuclear forensics lab. Dr. Castano gave us a book outlining experiments that we then set up. Reviewing the experiment I found out that we would need an alpha spectrometer. Dr. Usman's lab had an alpha spectrometer and I spent most of my time calibrating and setting up the equipment.

Rob Zedric: I'm a junior from Decatur, IL. Apart from classes, I keep myself busy on the Rolla Rural Fire Department, where I'm a firefighter and an EMT. In my free time, I enjoy shooting guns, snowboarding, and building electronics. Though I came to Rolla for mining, I switched to nuclear engineering when I realized I didn't like rocks. I wanted something more energetic and challenging, and I hoped to find it in this rarefied. Soon after I met Dr. Castano in his Intro to Nuclear class, he told me he was founding a nuclear laboratory on campus and wanted student workers to help. I thought it would be a great opportunity to get involved in research, so I signed up. Right away, he gave me experiments to work on and a laboratory to work in. I am currently evaluating a technique to measure radium concentrations in ground water, but will soon move on to bigger and better things.