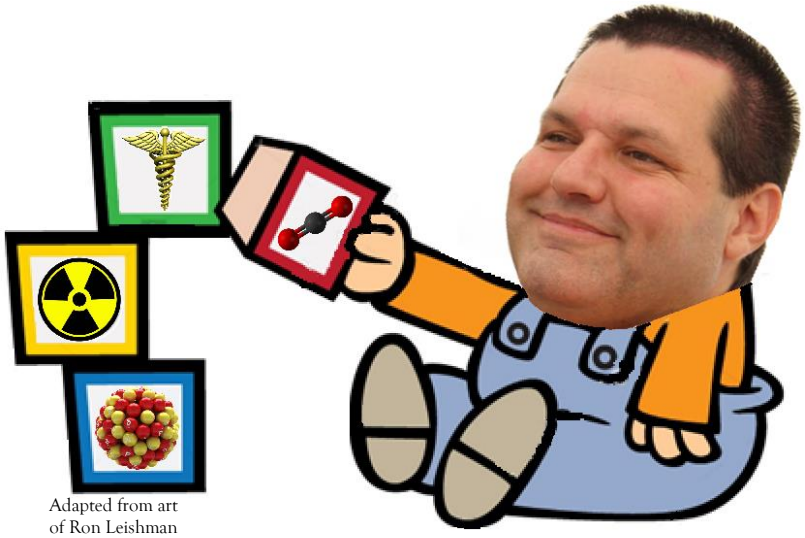
Consolidating Research Initiatives

Dr. Castaño's Report:



Adapted from art
of Ron Leishman

2016-2017 has been an interesting year that has witnessed initial work on designing and building the CO_2 reduction experiment an initiative with Dr. Graham and Lewis Rauschelbach. We are working under the auspices of GAANN (Graduate Assistance in Areas of National Need), energy being an area of national need. We will be soon be able to tell if the idea of direct reduction of CO_2 with nuclear has substantial merit and we can design a nuclear reactor around the idea. If so, nuclear reactors optimized for conversion of nuclear to chemical energy may become an eventual reality unshackling our overwhelming dependence to fossil fuels. Last year, we obtained a Missouri S&T Innovation Grant (http://innovate.mst.edu) to create the protocols for the creation of radionanoisotopes (radioisotopes in nanoscales), create of a mice colony, and a integrate it with the gamma imaging facility that Dr. Liu currently have in Fulton 227. The objective of this project is that we will be able to produce and test new types of radioisotopes that can be used for new cancer treatments. The team for this effort include Camila Garcia, Jenna Slocum, Dr. Schlegel, Dr. Liu and myself. If successful, we may be able to track and image accumulation of nanocompounds in the biological models (mice), study damage to some of the chemicals used to functionalize nanoradioisotopes, and determine the therapeutic dose (lethal/therapeutic amount) of some of these compounds. This is required preliminary steps before any new cancer treatment drug can be tested in humans. This year, I am trying to consolidate the main thrust to apply for grants to these two initiatives. However, other initiatives are ongoing, including the idea of the nuclear bar code, for which we are about to obtain a provisional patent with Dr. Johnson and James Seman. Also ongoing is the design and testing of new shielding materials that saw Raul Florez getting his MS degree. Last but not least, with the generous support of the Nuclear Engineering Program, we were able to conduct a variety of interesting experiments on the part of the senior students in reactor laboratory II. These experimental class is a valuable ground to give all our students a research experience as well as a testbed for many interesting research concepts that might eventually become full fledge research areas. While there is no space to put all initiatives, here are the most interesting and successful:

1. Abigail Dare, Jacob McFarland, Mikayla Molnar, and Sven Olberg for the first time generated boron nanoparticles using the radiation reduction method. The nanoparticles appear to be approximately 150nm in diameter. Medical applications probably will favor 50nm, so more work is planned.
2. Wil Fors, Philip Honnold, Tom Korenak, and Joshua Nixon also produced samples of 709 stainless steel in the foundry. This is important because 709 is a new steel being tested for high temperature systems, but making samples is usually expensive and only possible to do in big batches. We casted and tested only a few pounds of steel in our in-campus facility.
3. Dalton Akley, David Clark, Trevor Rucker, and Jacob Stueck tested the effect of voids in the worth of the Reg Rod in MSTR. In a paper we published this year, we used the worth of the reg rod to find the value of void coefficient of reactivity. One of the reviewers pointed to the possible effect of the void in the reg rod worth itself. We tested this, and found that indeed, depending on the position of the void, the worth of the reg rod can change by as much as 15%. Another paper will be prepared to explain this oversized and unexpected effect.
4. Payton Bruckmeier, Ben Foster, Bryant Kanies, and Sara Thompson studied the expected effect of 8 years of space irradiation on LEDs used in spacecraft. This project was conducted with hardware and help from the Naval Research Lab. Interestingly, LED's are little affected by this amount of dose.
5. Mitchell Manley, Luke Moehlenbrock, Austin Schrum, and Benjamin Turpin studied fatigue in nuclear materials using Krouse bending specimen prepared on campus. The values obtained were comparable to known fatigue values in the materials. Pointing to the benefit of this technique for testing fatigue of small specimens that fit high flux research reactors (e.g. HFIR, ATR).

As usual, I like to recognize my colleagues and students that contribute to the continued success of the nuclear engineering department. In particular, I would like to mention:

Prof. Catherine Johnson: Dr. Johnson is a professor Mining and Explosives at S&T. We are in the same department in different programs. Dr. Johnson and I are collaborating on the development of a "nuclear bar code" which is basically microscopic addition of rare earths to sensitive materials (explosives, special material) such that even after catastrophic events or interdictions the material can be attributed.

Prof. Henry Colorado: Dr. Colorado is a professor of Mechanical Engineering and Materials at the University of Antioquia (Colombia). Our cooperation extend many years on ceramic materials for structural and shielding applications that can resist fire and shock conditions possibly to be encountered in transportation of nuclear material accidents. We have also published a book chapter on the application of chemically bonded phosphate ceramics for nuclear waste applications, and have co-advised several students.

Maria Camila Garcia: Maria Camila obtained her MS degree by making radioactive nanoparticles with suitable characteristics to be used in cancer diagnosis and treatment. The synthesis process was conducted by irradiating with gamma and neutron at the same time. This technique has the advantage of producing well-characterized radioactive nanoparticles in a single step reducing the complexity and cost of producing specialty drugs for cancer treatment. This study included metallic and bimetallic nanoparticles. Maria Camila has since moved to pursue her PhD degree.

James Seman: James is pursuing his PhD in explosives engineering and is conducting research with Dr. Johnson and I. He is actively testing the concept of the nuclear bar code and is exploring the interfering of contaminants as well as detection limits as part of the implementation of the concept.

Lewis Rauschelbach: Lewis is a GAANN Fellow. GAANN is the Graduate Assistance in Areas of National Need is a program that assist graduate students with excellent academic records and projects useful for the US. We are demonstrating the concept of reducing CO_2 using nuclear radiation. This is the equivalent of converting nuclear energy directly to chemical energy.

Jenna Slocum: Jenna helped as an undergraduate with our research on radioactive nanoparticles and presented our work at the Undergraduate Research Day at the Capitol. She is currently Undergraduate Research Ambassador representing S&T in Jefferson City. She is interested in continuing the work with radioactive nanoparticles in-vivo systems (mice), and becoming an Academic Senator. I am looking forward to her continuing work in our group.