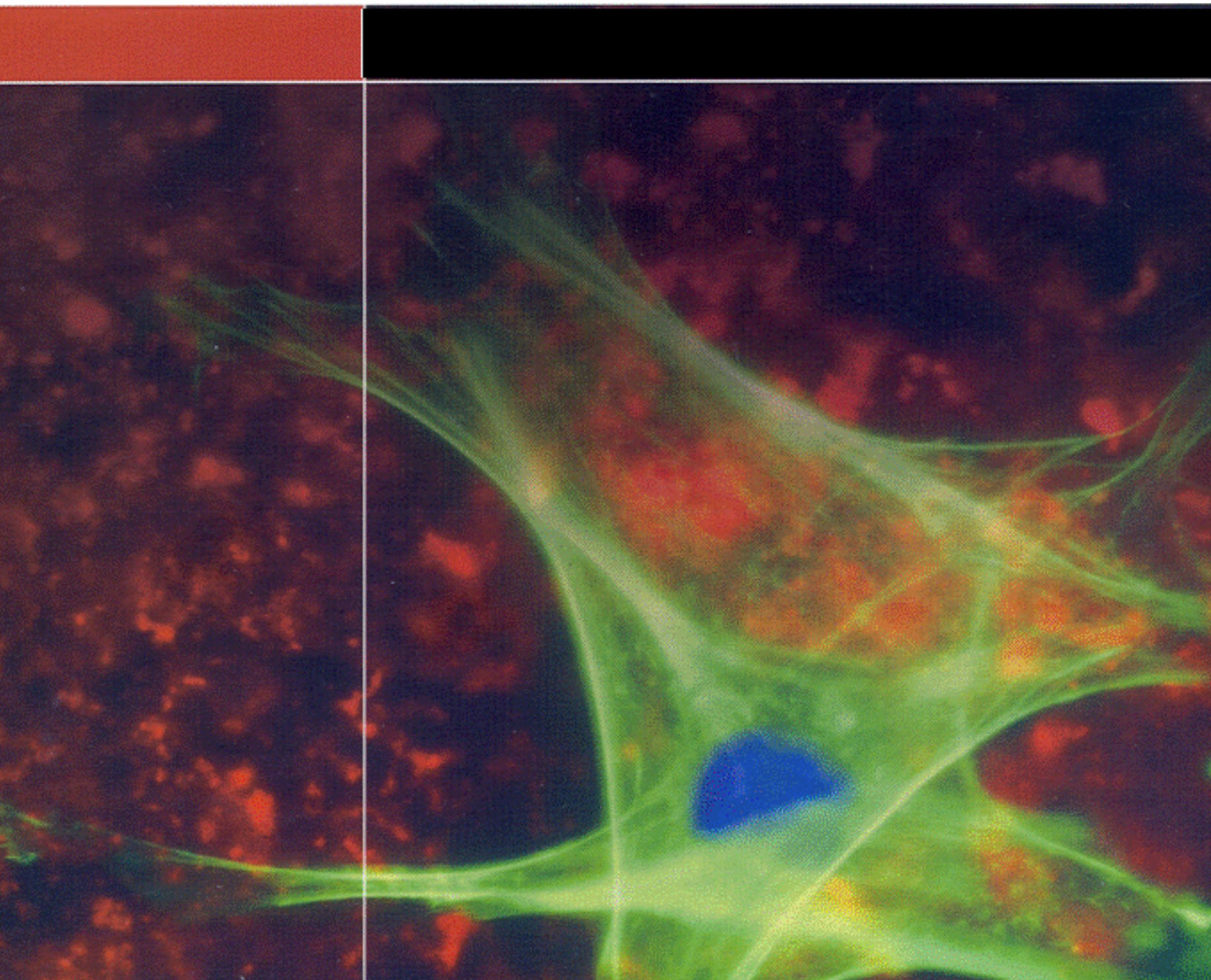
Howard J. Foster
Center for Irradiation of Materials

Sub-centers: Advanced Propulsion Materials
Integrated Environmental Research and Services



From The Director's Office

Daryush Ila,
Founder and Director
Howard J. Foster Center for
Irradiation of Materials
Alabama A&M University
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Alabama A&M University (AAMU) is a dynamic and progressive institution, founded by a former slave in 1875, with a strong commitment to academic and research excellence. Professor Daryush Ila, a graduate of Tehran University, MIT and the University of Lowell (now the University of Massachusetts Lowell) founded the Howard J. Foster Center for Irradiation of Materials (CIM) in 1991 to fulfill the objectives of a grant from NASA to analyze materials important to the space program.

Since 1991, members of the AAMU faculty have supervised more than 20 PhD theses and many masters' theses in materials science using CIM's original Pelletron ion accelerator, along with ion accelerators, implanters, and state-of-the-art optical, electrical, and mechanical material characterization instruments. CIM also contains more than $15 million in automated instrumentation for materials processing, characterization, and device prototyping. CIM is an internationally recognized science center and the only facility of its kind in an American university.

CIM has played a large part in more than 250 peer-reviewed articles (in recent years, 45 per year) published by AAMU students. CIM-managed activities have provided financial aid for nearly 200 students and summer training for more than 100. Grants and contracts with government and industry totaling more than $2 million provide almost the entire funding for the acquisitions of research instruments and material, maintenance costs and personnel expenses.

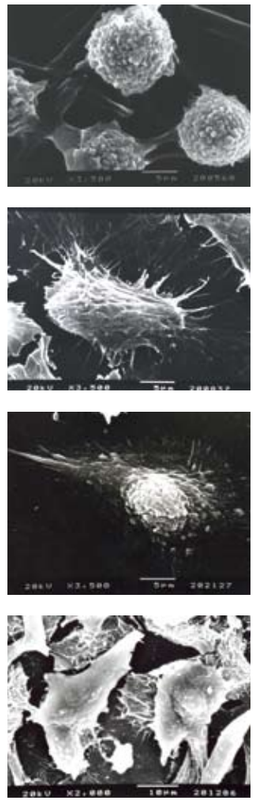
The highest priorities at CIM are to initiate AAMU undergraduate students into significant research with modern scientific instrumentation and to provide graduate students with an exceptional research environment where faculty, staff, students and internationally known visiting researchers explore the frontiers of materials science. CIM will continue to transform AAMU students into future leaders in science and technology while simultaneously serving industry, government and universities who require materials with innovative new properties.

Surface Modification For Cell Adhesion or Nano-Biological Interfacing:

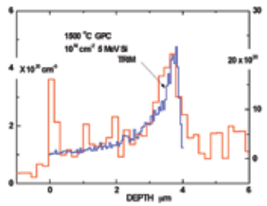
R.L. Zimmerman

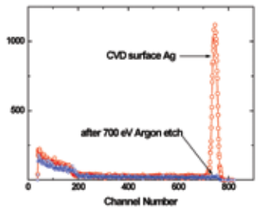
An important current medical challenge is the control of the location, orientation and type of cells that attach and develop on the surfaces of medical prosthetics. The surfaces of natural tissues, such as bone, collagen and other adjacent cells, provide physical and chemical cues such that the appropriate cell types develop and replace tissue lost through injury or disease.

Patterned silver ion implantation provides physical and chemical signals at the GPC surfaces and inhibits cell attachment. Nearby areas without silver are as acceptable to the cells as untreated GPC.



GPC Heart Valve





R.L. Zimmerman

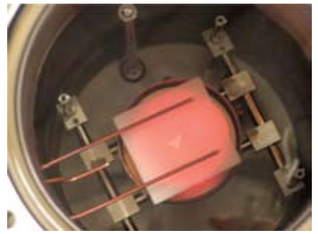
Sensors For Extreme Environments

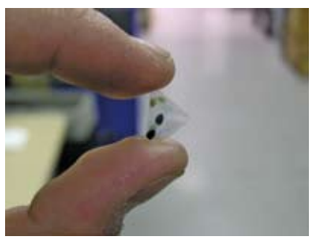
C.I. Muntele

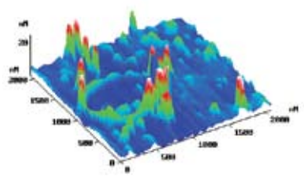
Understanding the fundamentals of the high temperature dynamics of silicon carbide electronics enable us to devise sensors capable of detecting small amounts of hydrogen (ppm range) in both inert and oxidizing hot environments such as:

- Jet engine sensors and control electronics
- Spacecraft power-conditioning electronics and sensors
- Transmitters for deep-well-drilling
- Industrial process measurement and control instrumentation
- “Distributorless” electronic ignitions
- Automotive engine sensors

C.I. Muntele



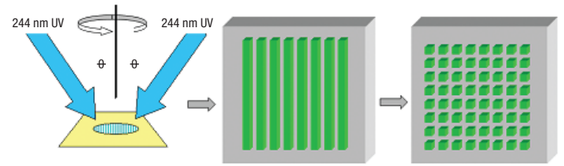


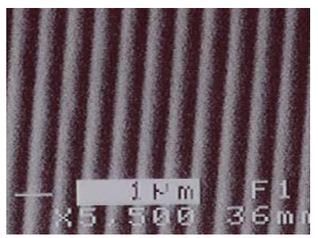


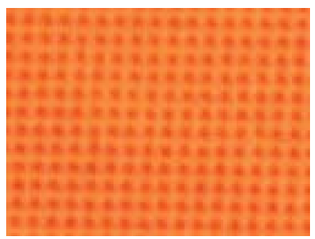
High Density Microarrays for DNA and Protein Sensors

A. Sharma

While current technology limits the size of each spot to 10-100 micron, UV lithography promises spot size of ~ 100 nm, i.e. 10,000 higher density, Holographic (Maskless) Lithography with 244 nm UV Laser Gratings and Hydrophilic Nanowells (30 nm deep) in polybutadiene for immobilizing Biomolecules.







A. Sharma

Nanostructured Materials: Advanced Power Conversion

D. Ila, S. Budak, S. Guner

Thermoelectric Materials:
Convert Heat to Electrical Power for space, medical and consumer applications.

Innovative techniques to measure

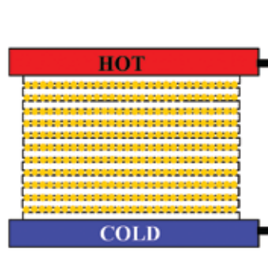
1. Thermal conductivity
2. Electrical conductivity
3. Seebeck coefficient

Objective: Increase and the efficiency of electrical power generation from heat.

D. Ila

S. Budak

S. Guner



Gold atoms implanted in an insulating medium (silica SiO_2) and bombarded with MeV ions from The AAMU Pelletron accelerator forms nano layers of quantum dots

$$\kappa = \frac{\phi}{\nabla T} \quad \text{watts / Kelvin - m}$$

$$\sigma = \frac{j}{E} \quad (\text{ohms - m})^{-1}$$

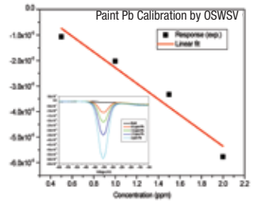
$$S = \frac{\nabla E}{\nabla T} \quad \text{volts / Kelvin}$$

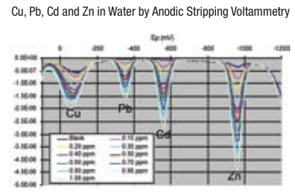
$$\text{Figure of Merit} = \frac{S^2 T \sigma}{\kappa}$$

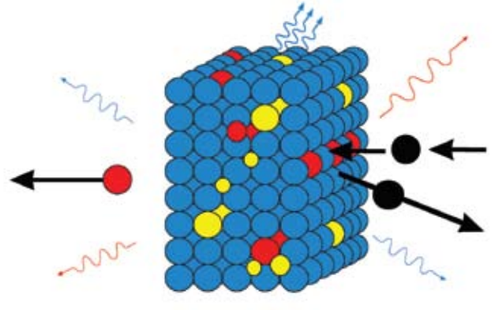
Forensic And Environmental Analysis: Research and Services

H.L. Bowman

Among the heavy metals and metalloid ions that are commonly found in environmental matrices, the most toxic are lead, cadmium, and mercury. These three heavy metals have no benign biological function and are toxic at all concentrations. We are using Proton Induced X-Ray Emission (PIXE – ion beam analytical method) and Cyclic Voltammetry (CV – electrochemical analytical method) in order to study the type and amount of heavy metal content in various environmental samples (aerosols, vegetation, soil, water, construction materials). Cyclic Voltammetry (CV) is often referred to as the electrochemistry equivalent of spectroscopy. Unlike PIXE, CV is not capable of analyzing multiple elements easily on just one experiment. CV is excellent for “target compound analysis” of from one to four elements (heavy metals). CV is capable of analyzing anions, cations and neutral molecules.





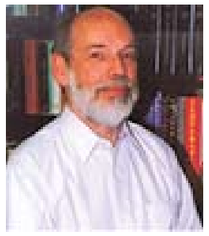


H.L. Bowman

Carbon Based Composites

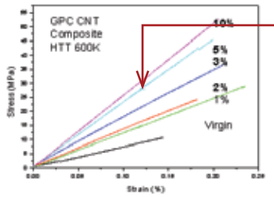
L.R. Holland, B. Chhay

Glassy polymeric carbon is hard as diamond, inert to 3000ºC, biocompatible. It has found applications in rocket engines, fusion and fission fuel containment and artificial heart valves. Its remarkable properties can be enhanced even more by addition of nano powders



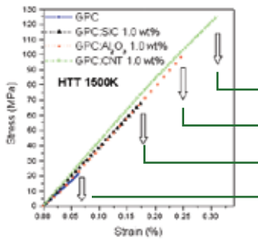
L.R. Holland

B. Chhay



Young's Modulus increases factor 3 by adding Carbon Nano Tubes

More Rigid



Nano Powders increase fracture strength

Strongest

Stronger

Strong

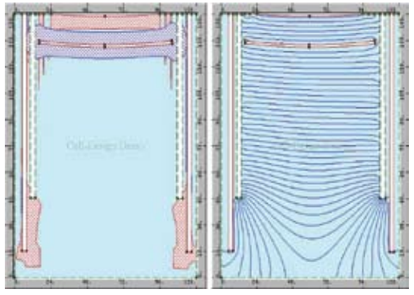
Pure glassy polymeric carbon

Ultra Light Mirror Laboratory
Production of optical and aerospace components

H.L. Bowman, L.R. Holland, D.B. Nisen

The Howard J. Foster Center for Irradiation of Materials has installed an electroplating facility for fabricating light weight Nickel-Cobalt reflective optical and aerospace components for extreme environments. Component diameters up to 36 inches may be accommodated in each of three thermally controlled 2000 liter tanks. The mandrel on which the component is electroformed is moved from one tank to another by a remotely controlled 500 kg gantry. Two other 2000 liter tanks are available for washing the finished component and for manipulating water and electrolyte. Independent current sources for the Nickel and Cobalt anodes are computer controlled to maintain zero stress in the component as it is being formed. The electrolyte is circulated to maintain constant purity, uniform temperature within 0.2ºC and zero concentration gradient.

The ULM laboratory is installed in a temperature controlled, positive pressure clean room. It has produced optical components for NASA and for local industries.



L.R. Holland,

R.L. Zimmerman,

D.B. Nisen,

and students

Partial List of Sponsors

NASA (MSFC, GRC, KSC)

DoD (ARO, SMDC, AFOSR, ONR)

DoE (ORNL, LLNL, SNL, NERI)

NSF

Private Industry (Raytheon, Boeing, VLOC, & Small Businesses)

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University of Alabama in Huntsville

University of Alabama in Birmingham

Tuskegee University

Vanderbilt University

Fisk University

University of Louisiana in Lafayette

University of Michigan

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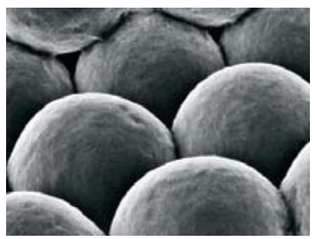
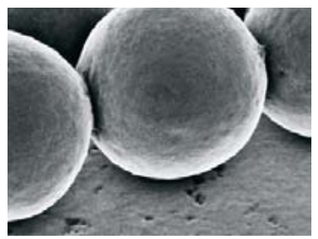
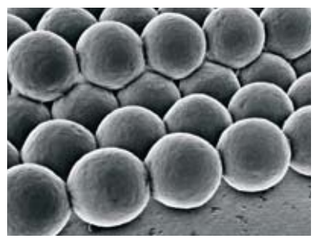
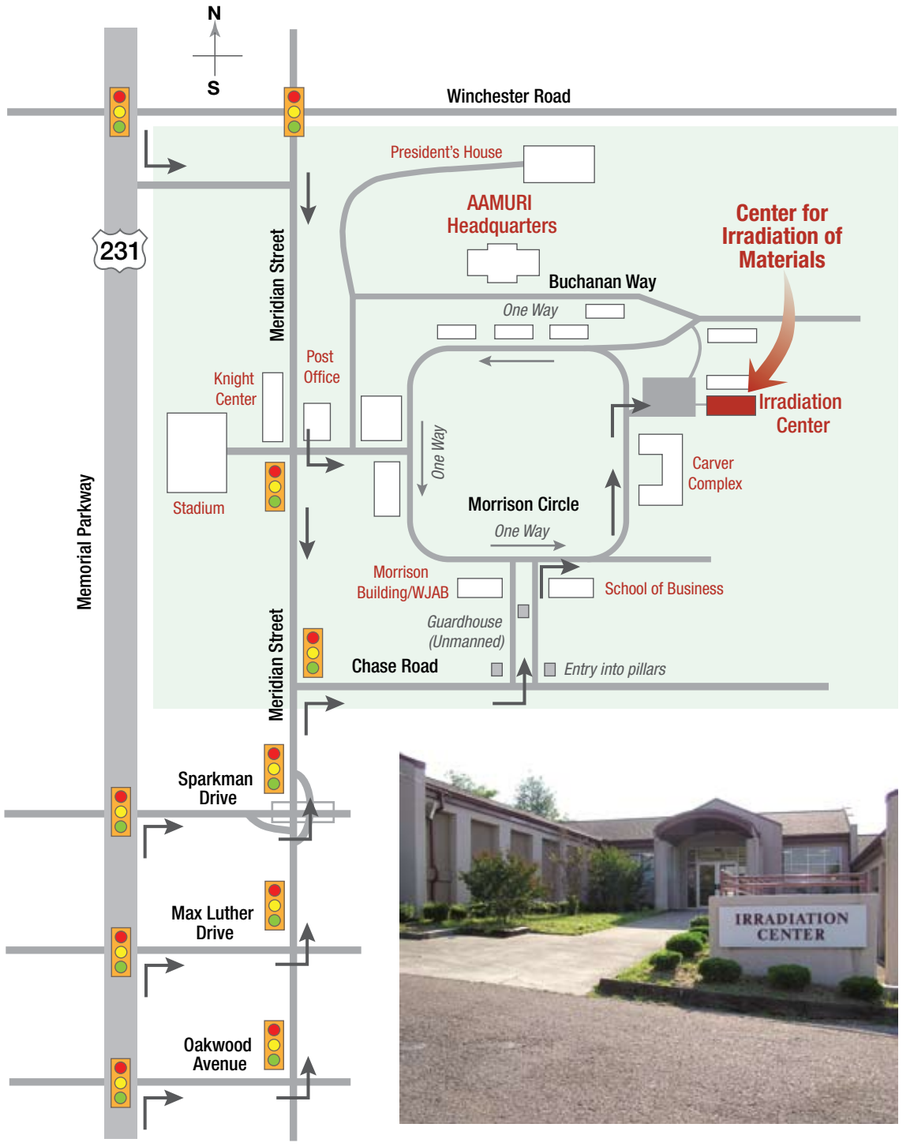






Directions to Irradiation Center



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