Dillard University
Capability Statement

Institution: **Dillard University**

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OVERVIEW

Dillard University was established in 1869 and is a private undergraduate Historically Black University. Dillard University has a distinctive strength in sciences. The Physics program, which is housed in the School of STEM and College of Arts and Sciences, is has been identified as one of the university's signature programs. The department was established in 1940 and most recently was nationally recognized as second in the Nation for graduating African American Females in Physics, as noted by the Associated Press, Washington Post, and many other outlets across the country.

The physics department houses pre-engineering, medical physics, and material physics programs. The physics department offers the undergraduate degree in physics with emphasis on research in optics, materials science, medical physics, and electrical, mechanical, and bio-medical engineering.

Dillard students continue to excel academically, winning major awards such as the Luard Scholarship. Students also participate in DoD-sponsored research and earn placement in prestigious graduate programs throughout the nation. With 151 years of academic excellence to its name, Dillard University continues its historical commitment to excellence in education and strives to position itself as one of the nation's premier centers for undergraduate research.

RESEARCH CAPABILITIES

Physics/Pre-Engineering Department: *Energy harvesting materials* fabrication and characterization, nanocomposite materials, organic-inorganic thin film nanocomposite materials fabrication for optical, Bio and chemical sensors, and harsh environment materials, superconducting, explosive detection and characterization, and modeling. Three-D printing and Quantum computing.

FACILITIES

Major& Specialized Instrumentation- Scanning Transmission Electron Microscopy, Transmission Electron Microscope, XRF florescence, XRD, Spectrograph, Raman Spectrometer, NIR- UV/Vis absorption spectrometer. Two major lasers Nd:YAG 10 Hz and 50 Hz, Lasers, Quanta Ray 10 and 50 Hz (1064 nm, 534nm, 355nm and 266 nm), OPO, CO_2 lasers, Femto-second laser 720 nm, 800 nm and 820 nm, High speed camera (One millions frames per second), Fluorescence Microscopy, Particle Size Analyzer, thin film thickness measurements, Atomic Force Microscope, 3- D Printing, Real time PCR, flow cytometer, Atomic absorption Spectroscopy, GC-Mass Spectroscopy, FTIR, UV-VIS-NIR spectrometer, Spectrograph, RHEED (Reflected High Electron Energy Deflection), 12 , 24 and 30 inches Pulsed laser Deposition chambers using the new innovative Patented technique of Double and triple DT-PLD and concurrent Double and Triple Matrix Assisted Pulsed Laser evaporation MAPLE systems DT-MAPLE for fabrication nanocomposite thin films.

Current and PAST PERFORMANCE

The Physics and pre-Engineering department under the chairman Presidential Professor Dr. Darwish has successfully completed numerous research and training projects sponsored by The Air Force of Office of Scientific Research (AFOSR), Army Research Laboratory (ARL), Army Research Office, NASA EPSCoR, NASA CAN, The National Science Foundation, and a number of private foundations. Most recently, Presidential Professor Abdalla Darwish received $913,543 grant from AFOSR for a total of $25.4M funding to his credit since he joined DU in 1998. His Research has included the development of chemical and biological sensors to detect nerve agents and explosives, and screening of the toxicity of organophosphate compounds. The AFOSR supported Pulsed laser deposition of Hard and soft materials, while the Army Research Labs provided support for the development of energy harvesting materials and others. His patents on energy harvesting materials was inspired by Hurricane Katrina to develop type of thermal harvesting materials which can turn any piece of glass or windows into electric resource of energy. International collaboration around energy harvesting materials projects have also flourished with Italy, Japan, and many others. The University through the work of Professor Darwish, is also engaged in a Joint Work Statement (JWS) and Cooperative Research and Development Agreements (CRADA) with both ARL for five years (POC Professor Darwish)and two Educational partnership agreements (EPA)with ARL in Dayton and Rome NY (POC is Professor Abdalla Darwish). Established a current MOU for faculty and students exchange research in energy harvesting materials with Shibaura Institute of Technology, Tokyo, Japan which resulted in faculty, students exchange, Patent and publications.

Services:

The physics and pre-Engineering department is housing extensive major infrastructure of testing equipment which can be produced Optical and nondestructive testing of nanocomposite materials, energy harvesting materials, petroleum compounds, optical and chemical sensors and many other services which required a very accurate data. From X-Ray machines like XRD and XRF to FTIR, Absorption spectrometer UV-VIS-NIR , all types of lasers from nanosecond to femtosecond pulses, from deep UV to 10.6 micron which can give may different optical testing with absorbance and reflectance of materials to measuring the index of reflation of materials. In addition, with the pulsed laser deposition double and triple, we are able to coat materials with different coats suitable for many different industrial applications. With the Scan Electron microscope and transmission Electron microscope much can be done and service for materials characterizations.

Patents:

5/7/2019

Dr. Abdalla Darwish, a Presidential Professor and Professor of physics at Dillard University, was awarded by USPTO with patent No US 10,283,691 B2 for his invention of NANO-COMPOSITE THERMO-ELECTRIC ENERGY CONVERTER AND FABRICATION METHOD THEREOF. The invention relates to a nanocomposite thermoelectric energy converter. The converter may be deposited on rigid or flexible substrates for a wide range of applications including portable electric power sources for wearable electronics and health monitors and the converters of waste heat into electricity.

The converter comprising a composite thin film inorganic semiconductor having carbonized polymer nano-clusters and the net of polymer nano-fibers included within. The carbonized polymer nanoclusters and nano-fibers improve the thermoelectric figure of merit by increasing electrical conductivity and decreasing thermal conductivity. The converter may be fabricated by a dual beam pulsed laser deposition process which was invented by Professor Darwish. A first laser beam evaporates a target comprising the materials of the inorganic semiconductor. A second laser beam evaporates the polymer using a matrix assisted target for depositing the polymer concurrently with the semiconductor deposition to yield the composite film. The lasers may be separately controlled to determine the resulting composition. The invention is a result of the research supported by and Air Force Office of scientific Research AFOSR Grant FA9550-12-1-0068 and US Army Grant W911NF -15-1-0446.

6/11/2019

Dr. Abdalla Darwish, professor of physics at Dillard University, was awarded by USPTO with patent No US 10,316,403 B2 for his invention of METHOD FOR OPEN-AIR PULSED LASER DEPOSITION. The invention relates to a method for open-air pulsed laser deposition by providing a target and a substrate, configuring a laser directed to the target, reducing the pressure in the zone between the target and substrate by providing a suction having an opening proximal to the target. Optionally, shielding the zone between the target and substrate from ambient oxygen by flowing an inert gas from outside the zone. The method may accommodate very large substrates and multiple targets and multiple laser beams. The target may be tilted or remotely tilted. Matrix assisted pulsed laser deposition of organic substances sensitive to atmospheric oxygen may be utilized as well. The invention is a result of research supported by US Air Force Grants No FA9550-12-1-0068 and W911NF -15-1-0446.

7/13/2021

The Presidential Professor, Dr. Abdalla Darwish, professor of physics at Dillard University, was awarded by USPTO with patent No US 11,059,128 B2 for his invention of MULTIPLE BEAM PULSED LASER DEPOSITION OF COMPOSITE FILMS. The invention relates to a system and method for multiple beam laser deposition of thin films wherein separate laser beams are used to ablate material from separate targets for concurrent deposition on a common substrate. The targets may include, but not limited to polymers, organics, inorganics, nanocrystals, solutions, or mixtures of materials. A target may be disposed on a tiltable mount to adjust the direction of the ablation plumes. Multiple ablation modes may be concurrently employed at the various targets, including, but not limited to pulsed laser, MAPLE, IR-MAPLE, and other modes. The system may include a camera and processor for plume axis determination and feedback control of the plume axis by controlling a tilt of a target holder. MAPLE target loading sequences and liquid states are described. Fluorescent image monitoring is described. The invention is a result of the research supported by US Air Force Grants No FA9550-12-1-0068, and FA9550-18-1-0364.

- Most recently, Dillard University has joined the IBM Quantum computing HBCU center for HBCU/MI.

- **The flow chart of the process of Concurrent Double/ Triple PLD/ MAPLE Film fabrication and characterization**