Research and Education Overview

Presented by

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&
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Dean, College of Engineering
at

NASA Road Infusion Tour
UNLV

Tuskegee University
January 10, 2017
History

• The Institution was founded as Normal School in 1881 by its first President Booker T. Washington.
• It was renamed Tuskegee Institute in 1937.
• It was named Tuskegee University in 1986 by its fifth President Dr. Benjamin Patton.
• The University’s Third President, Dr. Frederick Patterson founded the United Negro College Fund in 1944.
• Tuskegee University was the first Black College to be designated as a Registered National historic Landmark in 1966.
• Tuskegee University is the only college to be designated a National historic Site in 1974.
• First Master’s Degree Program in Agriculture, Education and Home Economics was offered in 1944.
• First Ph.D. program in Materials Science & Engineering offered in 1998.
Points of Distinction

• The university is the largest producer of African-Americans with baccalaureate degrees in math, science and engineering in Alabama.
• Tuskegee’s Materials Science and Engineering Program graduates the largest number of black PhD students in the U.S.
• Tuskegee University is the No. 1 producer of African-American aerospace science engineers in the nation.
• Tuskegee University is the only HBCU with a fully accredited College of Veterinary Medicine that produces over 75 percent of the African-American Veterinarians.
• Tuskegee is the only college or university campus in the nation to be designated a National Historic Site by the U.S. Congress.
• More U.S. presidents have visited Tuskegee University than any other historically black college or university.
• The Tuskegee Airman, who trained at the Tuskegee Air Field in July 1941, were the first African-American fighter pilots in the U.S. Army Air Corps.
• The ROTC program at Tuskegee has produced more African-American general officers in the military than any other institution, including the service academies.
• Tuskegee University is the leading producer in the country of African-American engineering graduates in chemical, electrical and mechanical engineering.
• Tuskegee University is the only HBCU in the nation designated as the location for National Center for Bioethics in Research and Health Care.
Colleges and Schools

Andrew F. Brimmer College of Business & Information Science
College of Agriculture, Environment & Nutrition Science
College of Arts & Science
College of Engineering
College of Veterinary Medicine,
Robert R. Taylor School of Architecture & Construction Science
School of Education
School of Nursing and Allied Health
Graduate Degrees

Doctor of Philosophy

• Integrative Biosciences
• Integrative Public Policy & Development
• Interdisciplinary Pathobiology
• Materials Science & Engineering
Graduate Degrees (Cont’d.)

Master of Science

• Agricultural & Resource Economics
• Animal Sciences
• Biology
• Chemical Engineering
• Chemistry
• Electrical Engineering
• Environmental Science
• Food & Nutritional Science
• Information Systems & Security Management
• Materials Science & Engineering
• Master in Public Health & Public Health
• Mechanical Engineering
• Occupational Therapy
• Plant & Soil Sciences
• Veterinary Sciences (NOT DVM)

Online Degrees

• Environmental Management
• Environmental Science
• Information Systems & Security Management
Research Expertise

- Additive Manufacturing
- Animal and Poultry Sciences
- Biological and Biomedical Sciences
- Food and Nutrition Sciences
- Computer Science and Information Security
- Energy Generation, Storage and Transportation
- Environmental, Natural Resources and Plant Sciences
- Materials Science and Engineering
- NanoBioTechnology
- Semiconductors and Microelectronics
- Veterinary Medicine
Funding Agencies

- National Aeronautics and Space Administration (NASA)
- National Science Foundation (NSF)
- Smithsonian Institute
- U.S. Department of Defense (DOD: Airforce, Army, Navy)
- U.S. Department of Homeland Security (DHS)
- U.S. Department of Energy (DOE)
- Humanities (NEH)
- National Endowment for
- U.S. Department of Agriculture (USDA)
- U.S. Department of Education (DOEd)
- U.S. Department of Health and Human Services (HHS)
- U.S. Department of Interior (DOI)
- U.S. Department of Transportation (DOT)
- State of Alabama
- Industry
# 2014-2015 Funding by Colleges and Other Units

<table>
<thead>
<tr>
<th>Academic Areas/Centers/Other Major Units</th>
<th>No. of Awards</th>
<th>Dollar Amount</th>
</tr>
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<tbody>
<tr>
<td>College of Agriculture, Environmental and Nutrition Sciences (CAENS)</td>
<td>77</td>
<td>$15,359,131</td>
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<tr>
<td>College of Arts and Sciences (CAS)</td>
<td>13</td>
<td>$2,705,609</td>
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<tr>
<td>College of Business and Information Science (CBIS)</td>
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<td>$250,663</td>
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<tr>
<td>College of Engineering (CE)</td>
<td>50</td>
<td>$10,106,322</td>
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<td>College of Veterinary Medicine, Nursing and Allied Health (CVMNAH)</td>
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<td>$11,316,282</td>
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<td>School of Architecture (SOA)</td>
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<td>$12,000</td>
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<tr>
<td>School of Education (SED)</td>
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<tr>
<td>Bioethics Center</td>
<td>5</td>
<td>$296,471</td>
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<td>Center for Biomedical Research (CBR)/RCMI</td>
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<td>International Programs</td>
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<td>Health Disparities Institute for Research &amp; Education (HDIRE)</td>
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<td>$0.00</td>
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<td>President’s Office</td>
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<td>$3,032,125</td>
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<td>Provost (Library)</td>
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<td>$90,000</td>
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<td>Student Affairs</td>
<td>1</td>
<td>$383,897</td>
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<td><strong>TOTAL</strong></td>
<td><strong>187</strong></td>
<td><strong>$44,364,365</strong></td>
</tr>
</tbody>
</table>
2014-2015 Funding by Agencies

- DHS: $579,130, 2%
- DOD: $583,854, 2%
- DOE: $295,000, 1%
- DOT: $27,500, 0%
- HHS: $9,856,214, 28%
- NASA: $20,880, 0%
- NSF: $7,258,562, 20%
- Smithsonian Institute: $4,000, 0%
- USDA: $10,943,611, 31%
- DOI: $50,000, 0%
- DOEd: $5,569,206, 16%
Compliance Committees

- Animal Care and Use Committee (IACUC)
- Biosafety Committee
- Intellectual Property Committee (IP)
- Institution Review Board (IRB)
- Radiation Safety Committee
- Policy to Respond to Scientific Misconduct
Core Strengths and Capabilities - College of Engineering

**Aerospace:** experimental aerodynamics, vortex-dominated flows, flight simulation, configuration aerodynamics, human interface.

**Chemical:** microfluidics, corrosion, carbon capture, bio-fuels, adsorption, water & wastewater treatment, smart manufacturing, bio-chemical engineering, chemical process modeling.

**Electrical:** electronic warfare and technology; systems engineering; control systems, wireless sensors and data gathering networks, information assurance; integrated circuits; cyber; power/energy.

**Mechanical:** fracture and fatigue evaluation, additive manufacturing, proton and ion conductive membranes, corrosion and coatings, environmental aging of materials, dislocation dynamics in materials, fuel cells.

**Materials Science & Engineering:** synthesis and chemical analysis of materials, processing of bio materials, performance and nondestructive evaluation, and modeling.

- Number of students: ~600 undergraduate and ~40 graduate
- Number of Faculty and Staff: 36 and 10
- Number of graduates ~ 100
- Annual Research Awards: ~ $10 M
- Refereed Publications ~ 50/ year
Research Capability: Materials Science and Engineering
Bio-Nanocomposites Research

Biomass

Extraction and deconstruction of cellulose for production of biorenewal chemicals and plastics

Nanoparticles

Synthesis and characterization of mono- and multimetal nanoparticles

Outcome

Benign by Design

3-D Membranes

Development of gradient based films for removal of CO₂ and H₂S from Shale gas.

Sustainable materials and processes for nano-enabled technologies

Fig. 4. Linkages common to MOFs: (left) Mg(BDC), BDC = 1,4-benzenedicarboxylate; (center) Mg(RTC), RTC = 1,3,5-benzene1,2,4-tricarboxylate; (right) Mg(RTC) used in ZIFs.
Eggshell Nanoparticle Synthesis

Eggs shells, which end up as waste materials are used in our research to synthesize calcium carbonate nanoparticles. These nanoparticles are further used to strengthen polymers, precursors to synthesize other nanoparticles for several medical, pharmaceutical, and structural applications. In this work, we collaborate with researchers from other colleges in the university and other universities.

Synthesized CaCO$_3$ particles

Ground eggshells

Nanoparticle based drug delivery tablet developed for cancer treatment
Nanostructured Thin Films and Coatings

NANOSTRUCTURED THERMOPLASTIC POLYIMIDE FILMS
Date of Patent: May 19, 2015
Assignee: Tuskegee University

Proton Conductive Membrane

Aluminum substrates without and with nanostructured coatings

Steel substrates without and with nanostructured coatings
Hypervelocity Impact Analysis of Space Materials

Plasma Drag Hypervelocity Particle Accelerator

Aluminum Alloy
Phenolic Resin
Silicon Carbide

Funded by MDA
ABSTRACT
A multi-pass gas metal arc weld ("GMAW") approach is used for in-situ repair of railhead defects. A defect is removed via machining a perpendicular slot or groove in the railhead leaving the web and base unaltered. A sufficient number of GMAW passes are used to fill the slot using a weld material suitable for the particular type of parent steel, and excess weldment can be removed. Optionally, for pearlitic steel rails post-weld heat treatment can be used to cause austenization and/or quenching of the weld. The weld heat inputs and other parameters are controlled to avoid ductile and brittle fracture related morphologies.
Education, Outreach, and Student Success

Middle school students hands-on activities

Teacher training activities

Dr. Kristy Crews (2016 graduate) with mentor Dr. Curry

REU student Demetrius Findley

Summer FASTREC student activities

International Collaborations
Research Capability: Mechanical Engineering
Testing and Evaluation of Materials and Components under Combined Environmental Conditions

Environmental conditions:
- ASTM B117 SALT SPRAY TESTING (Salt fog testing)
- ASTM G85:A4 SALT/SO₂ FOG (Spray testing)
- Sand cloud exposure
- UV aging

A combination of the above tests

Funded by Raytheon
Tin Whisker Growth under Hygrothermal and/or Corrosive Environment Exposure

Test Chamber

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight%</th>
<th>At%ncts</th>
<th>Conc%</th>
<th>Formula</th>
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<tbody>
<tr>
<td>N K</td>
<td>6.42</td>
<td>1.44</td>
<td>1.61</td>
<td>N2O5</td>
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<td>Sn T</td>
<td>77.50</td>
<td>31.65</td>
<td>96.39</td>
<td>SnO2</td>
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<tr>
<td>O</td>
<td>22.08</td>
<td>66.91</td>
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<tr>
<td>Totals</td>
<td>100.00</td>
<td></td>
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</tr>
</tbody>
</table>

Funded by The Boeing Company
Super Sonic Flow Mixing Using Ultrasonic Microactuators

High speed flow diagnostic lab

Proposed idea for high speed mixing

Actuator Frequency

Flowfield

Supported by National Science Foundation: PI Dr. John Solomon, Mechanical engineering
Research Capability: Aerospace Science Engineering
Highly Efficient High Fidelity Computational Schemes

- High-fidelity computational analysis of hypersonic and supersonic flow fields
  - Implementation of high-resolution numerical schemes for modeling shock/boundary layer interaction phenomenon
    - Total Variation Diminishing (TVD)
    - Weighted Essentially Non-Oscillatory (WENO)
    - Direct Numerical Simulation (DNS) of turbulent supersonic cavity flow
  - Magneto-hydrodynamics (MHD) hypersonic/supersonic flows
    - Navier-Stokes and Ampere-Maxwell equations
    - Approximate formulation
    - Multi-block solver
  - Tip-leakage flow of surface-mounted obstacles
  - Heat transfer analysis

- Resources
  - Self-developed computer codes
    - FORTRAN, MATLAB
  - Commercial grid generators
    - Gridgen, Gambit
  - High Performance Computing
    - Alabama Supercomputing Authority
Experimental Investigation of Complex Vortex Dominated Flow

- Turbulent Mixing – Wake Flow of a Three Dimensional Wavy Cylinder Using Volumetric Particle Image Velocimetry, Proper Orthogonal Decomposition
Characterization of Magnetic Field of Pico/Nano/Micro-Satellites to Facilitate “Magnetic Cleanliness”

- Introduction & Background
  - Pico/Nano/Micro-satellites (PNMSats), particularly CubeSat class of satellites, are compactly packaged due to size, weight, & power (SWaP) constraints.
  - The magnetic activity & bias within these satellites can affect the performance of magnetically sensitive sensors, actuators & instrumentation.

- Research Goals & Objectives
  - Experimentally map the magnetic field of PNMSats in a Helmholtz Coil Cage.
  - Develop a mathematical model (static & dynamic) of the magnetic map.
  - Use the mathematical model to determine and cancel the magnetic bias at any position
  - Facilitate Magnetic Cleanliness of PNMSats
  - Refine attitude determination and control capability of PNMSats
Research Capability: Chemical Engineering
Biochar: CO₂ Sequestration and Soil Amendment

What is Biochar?

- Biochar is a stable recalcitrant carbon produced by thermal decomposition of biomass under oxygen-limited conditions (pyrolysis: <700 °C).
  - Agricultural crop residues
  - Forestry residues
  - Municipal solid waste & Animal manures

Environmental Carbon Accounting

Pyrolysis of Biomass

Results

SEMs of highly porous biochar from wood shavings (A) and Sugarcane Bagasse (B)
Specific Objective
Synthesize graphene/metal and graphene/metal oxide nanocomposites In situ with superior electrochemical properties.

Hydrothermal Synthesis Protocol

Research Capability: Electrical Engineering
Portable Smart Platforms for Detection of Biological Pathogens & Chemicals

- **Research:**
  - New, sensitive portable technologies for detection of pathogens & other bio-chemical threats.

- **Educational:**
  - Educate and train students at TU in homeland security - STEM areas.
  - Research experience and curriculum development.

![Portable detection platform based on Raman spectroscopy](image)

- Sensitive detection possible

*Funded by US Department of Homeland Security*
Center for Ultra-wide-area Resilient Electric Energy Transmission Networks (CURENT)

CURENT is an Engineering Research Center headquartered at the University of Tennessee-Knoxville and is funded by the National Science Foundation (NSF) and the Department of Energy (DOE).

Research Focuses:
• Power systems
• Power electronics
• Data visualization
• Cyber security
• Electronic power conversion
• Smart grid technology
• Power markets
• Electric vehicles
• Energy harvesting

University of Tennessee Knoxville
Northeastern University
Rensselaer Polytechnic Institute
Tuskegee University