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NANO MATERIALS RESEARCH AT TUSKEGEE UNIVERSITY

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ABSTRACT

Tuskegee University's Center for Advanced Materials (T-CAM) is the single largest multi-disciplinary research facility on Tuskegee University's campus which is operated with support from various federal agencies and industries. Research activities at T-CAM have been funded by the United States Air Force, Army, navy, National Aeronautics and Space Administration (NASA), National science Foundation (NSF) and industry including 3-M, Boeing, concurrent Technologies, General Motors, Lockheed Martin, and Raytheon Missile Systems. The Center has been contributing to basic and applied research in Materials Science and Engineering and is acclaimed nationally and internationally for over three decades for its enormous success in educating minorities in the science and engineering of advanced materials. T-CAM possesses state-of-the-art facilities to conduct research in all aspects of advanced materials and structures. The faculty and students associated with T-CAM are involved in basic applied research on materials related to current and future needs of a variety of defense, recreational, healthcare and commercial areas.

The Ph.D. Program in Materials Science and Engineering (MSE), designed to serve the multi-disciplinary challenges of science and technology, is also spearheaded by the Center. A broad spectrum of areas connected with materials science and engineering are available for Ph.D. level research. The program is designed such that students may join upon completion of either the Baccalaureate or the master's degree in Engineering, Physics, Chemistry or Mathematics. About twenty faculty members from disciplines of Aerospace, Chemical, Electrical and mechanical Engineering, Chemistry, Computer Science, Mathematics and Physics are part of the PhD program. We invite educators and researchers from universities (National and international), national laboratories and industry to collaborate with the Tuskegee University faculty associated with the T-CAM to develop state-of-the-art research and technology in advanced materials and prepare future faculty, scientist and entrepreneurs The mission of T-CAM is:

- To strive for a fundamental understanding of the nature of advanced materials towards the goal of military, industrial, recreational and healthcare related applications.
- To motivate and educate students, with emphasis on those from underrepresented groups, in the science and engineering of advanced materials.
- To offer outreach activities for K-12 students and teachers and community college students.

Earlier focus of research at the T-CAM was on the development of multifunctional, affordable and environmentally safe polymeric materials, particularly composites. In this regard, researchers associated with the center have developed innovative syntheses, processing, modeling and simulation, and characterization techniques that are still being used. T-CAM has been directed toward producing a variety of nanomaterials including metal and metal oxides, single and multi-walled carbon nanotubes, and their hybrid nanoparticles and using these materials as reinforcement to enhance mechanical, electrical, and thermal performance in a variety of applications. Specific products and processes that have been developed using nanofillers include sandwich composites, extruded multi-functional thermoplastic fibers; filament wound composite laminates, drug delivery, biocomposites, and shear thickening fluids for flexible body armors.

Figure 1 shows current active grants at the Center for Advanced Materials.

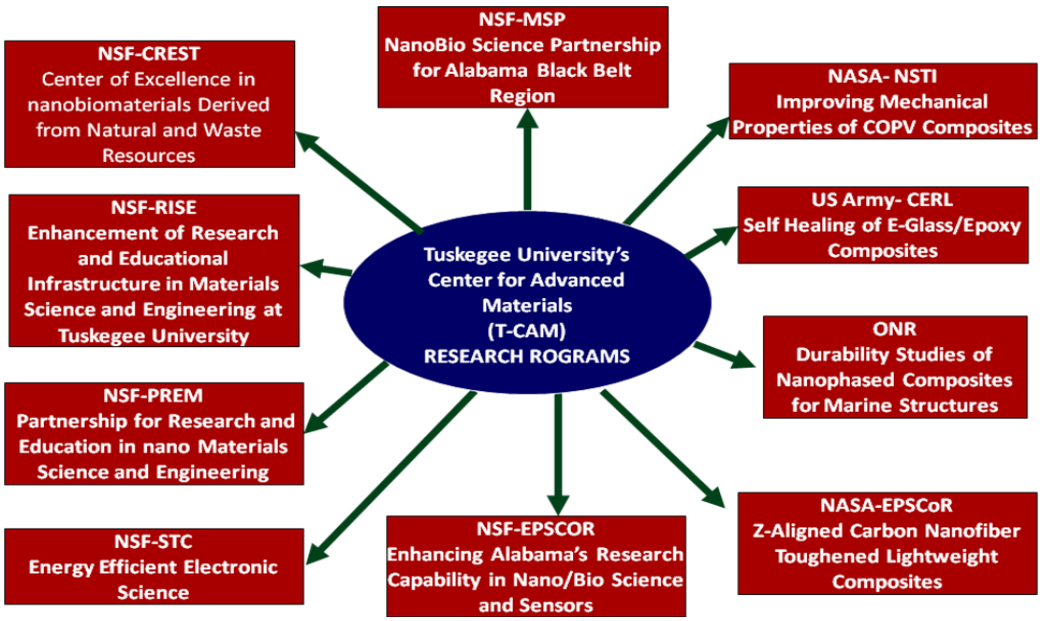

Fig 1. Active grants at Tuskegee University's Center for Advanced Materials.

Major research activities that are currently in progress at T-CAM are:

- Multifunctional Fiber Extrusion
- Shear Thickening Fluids for Flexible Body Armors
- Synthesis of Nano-Fillers: CNTs, Metals and Metal Oxides
- Synthesis of Nanoparticles for Drug Delivery Applications
- Polymer Modification for Multifunctionality
- Polymer Nanocomposites for Structural Applications
- Sandwich Composites
- Filament Winding
- Bio-Composites
- Sheet Molding Compounds

Through this presentation, the authors would like to highlight only a few research activities in the area of nanomaterials that distinguish Tuskegee University as a highly competitive research and educational institution in the field of advanced materials.

Multifunctional Fiber Extrusions

T-CAM has the capability to extrude fibers of various materials with nanofillers including carbon nanotubes to enhance the properties of the fibers for a variety of applications. The following figure shows enhancement in strength and stiffness of nylon-6 as the result of infusion of 1% by weight of carbon nanofibers, carbon nanotubes and SiO2 nanoparticles.

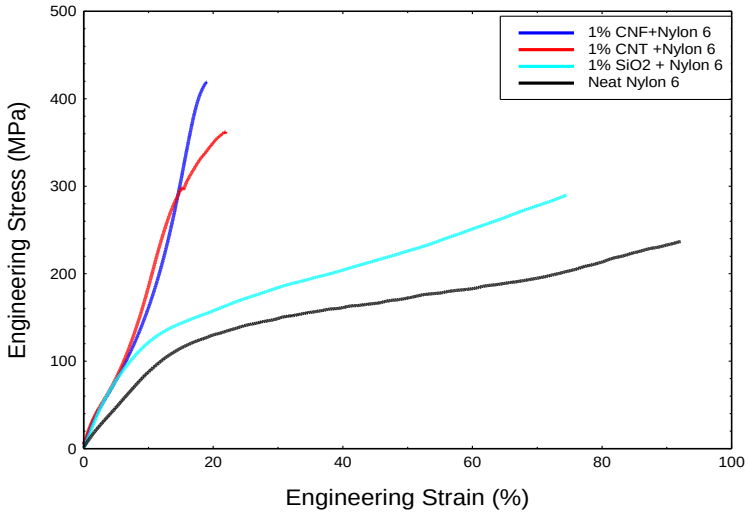

Fig 2. Stress-Strain behavior of Nylon 6 fiber reinforced with nanofillers.

Shear Thickening Fluids for Flexible Body Armors

It's possible to alter the shear rate Vs viscosity behavior of certain non,nutonion fluids by adding calculated amount of nanoparticles as shear thinning or thickening occurs in non-Newtonian fluids infused with nanoparticles. Figure 3 shows the shear thinning and thickening behavior of a non-nutonion fluid containing silica nanoparticles of ~15nm size. Shear thinning is characterized by a decrease in the viscisity of the fluid as the shear rate is increased, while shear thickening is characterized by a large, sometimes discontinuous increase in viscosity with increasing shear rate. Based on this phenomenon we have developed various processes to produce shear thickening fluids which can be used in developing flexible body armors to protect body extremities.

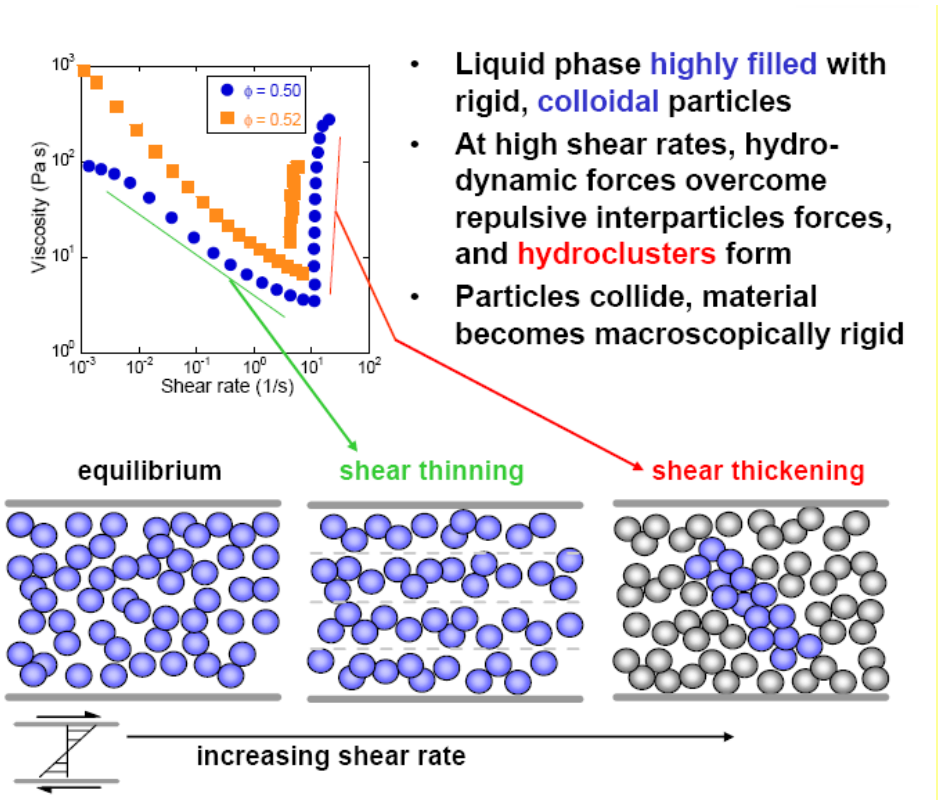

Fig 3. A Model of Shear Thinning and Thickening Process.

Nanoparticles for Medicinal Applications

We are currently working on designing a magnetic drug delivery system capable of delivering hydrophobic cancer drugs such as pacliatxel to a specific site with more accuracy and less toxicity than some current methods. These magnetic nanoparticles can also be used as a MRI contrasting agents and hypothermia therapy.

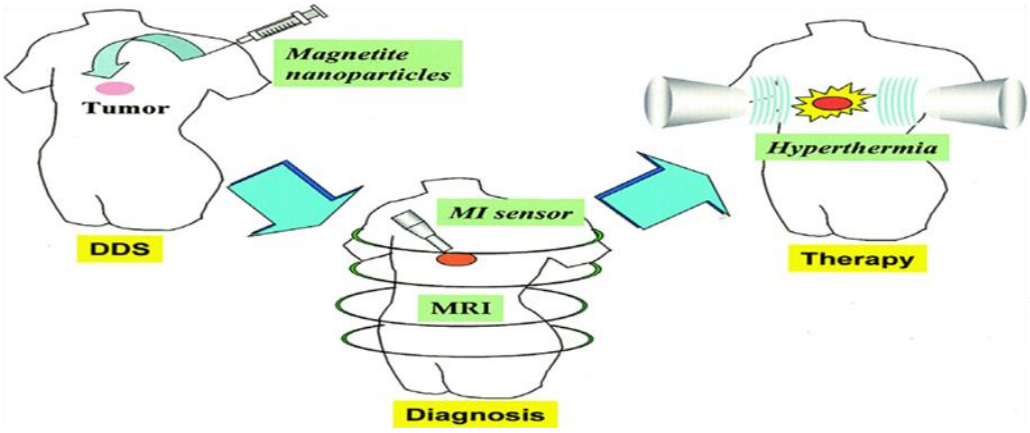

Fig 3. Drug delivery applications of synthesized nanoparticles.

MAILING ADDRESS

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