PTC Polymer Technology Central

UPCOMING EVENTS

Mark Your Calendars for the PTC Spring meetings!

Scratch Behavior of Polymers Consortium-SCRATCH

Spring-Monday, April 6th, 2020-Videoconference
Fall-Wednesday, October 7th, 2020
Noon—5pm
After the TPO Conference-TROY, MI

Polymer Technology Industrial Consortium-PTIC

Spring-April 17th, 2020-Videoconference
Fall-October 15th-16th, 2020
College Station, TX
Texas A&M University

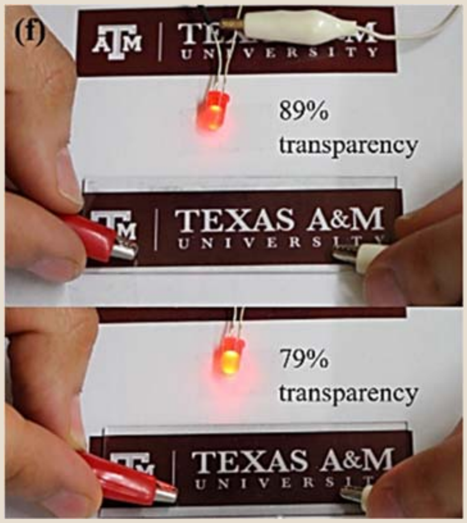
Inside the Newsletter

Highly conductive wires made from copper and carbon nanotubes

Professor Hung-Jue Sue
Materials Science and Engineering

There is a continuing search for methods to reduce power losses during electrical power transmission. The use of extra high voltages (>345 kV) and direct current are becoming more common. In work sponsored by Lloyd's Register Foundation, we are investigating the possibility of developing conductors with greater ampacity (current-carrying capability) compared to copper and aluminum. One of the targeted applications is for undersea cables for off-shore wind turbines.

Carbon nanotubes (CNTs) have exceptional conductivity and strength, but the commercially available nanotubes are typically short (micrometer length), and conversion of these nanotubes into practical wires has been a challenge. We've developed a process for coating CNTs with copper, which allows conduction between individual nanotubes. These coated nanotubes are dispersed in a polymer, converted into fibers using an electrospinning process, and then sintered to remove the polymer.



We've achieved an ampacity of 8.2×10^5 A/cm^2, about 40% higher than that of copper. In addition, we have observed that thin coatings of a suspension of these fibers have good transparency and conductivity. The images show two microscope slides that have been treated on one surface with our Cu/CNT fibers. The logo shows through the slides demonstrating the transparency at 550 nm, and conductivity is shown by passing a current to light an LED. The conductivity and transparency of the top film are comparable to indium-tin oxide, which is the commercial incumbent.

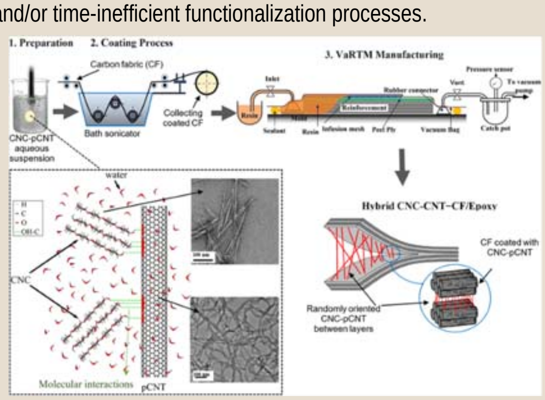
This ongoing project is being done in collaboration with the National Univ. of Singapore and the Univ. of Cambridge.

Cellulose-Nanocrystal Enabled Manufacturing of Hybrid Carbonaceous Nanomaterials/ Carbon Fiber Polymer Composites with Enhanced Properties

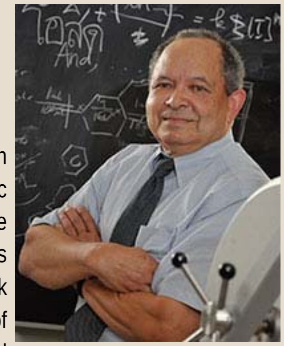
Assistant Professor Amir Asadi
Department of Engineering Technology and Industrial Distribution

Carbon fiber reinforced polymer (CFRP) composites have reached a plateau in their performance because carbon fibers cannot reach beyond 30% of their theoretical values, and delamination during service has still remained a major threat to the composite life. Theoretical and experimental studies suggest that integration of carbonaceous nanomaterials can overcome these limitations as they transfer their outstanding properties to the composite and enhance the structural and functional properties. However, incorporating nanomaterials often involves chemical functionalization, aggregation and non-uniform distribution that impair the final properties and hinder scalable manufacturing of hybrid CFRPs.

To overcome these challenges, professor Asadi has introduced a novel and scalable processing technique to integrate pristine carbon nanotubes (pCNTs) and graphene nanoplatelets (GNP) into CFRP composites without the need for chemical functionalization or adding surfactants. Dr. Asadi's group use cellulose nanocrystals (CNCs) as assisting nanomaterials to uniformly disperse and stabilize pCNTs and GNPs in water and then coat the carbon fibers (CFs) with CNC-pCNT or CNC-GNP prior to resin infusion (see Figure). CNCs are cellulose based, spindle-shaped nanoparticles (3-20 nm in width and 50-500 nm in length) with high mechanical properties (~10 GPa strength and ~150 GPa modulus and stability up to 300 °C) that can be extracted from trees and plants by acid hydrolyses. Moreover, Asadi's group has shown that addition of CNC and pCNT synergistically enhances the interlaminar shear strength (ILSS) to retard delamination and increases the thermal stability of composites compared to those of composites made with functionalized CNTs-coated carbon fibers. In addition to accelerated manufacturing of enhanced hybrid composites, this process allows harnessing the intermolecular interactions between individual constituents of hybrid CFRP, i.e. nanomaterials, carbon fiber, and polymer thus tailoring the structure and performance from nanoscale to higher scales. These results highlight that the introduced CNC-enabled processing-manufacturing technique is a potential scalable path towards fabricating hybrid composites that can enhance properties avoiding costly and/or time-inefficient functionalization processes.



Processing-manufacturing of CNC-CNT−CFRP hybrid composites. Step 1. Preparation of aqueous suspension of CNC-pCNT using probe sonication; schematic of intermolecular interaction between CNC and pCNT in water; Step 2. Coating process to deposit CNC-pCNT onto CF; Step 3. VaRTM manufacturing with coated CFs.

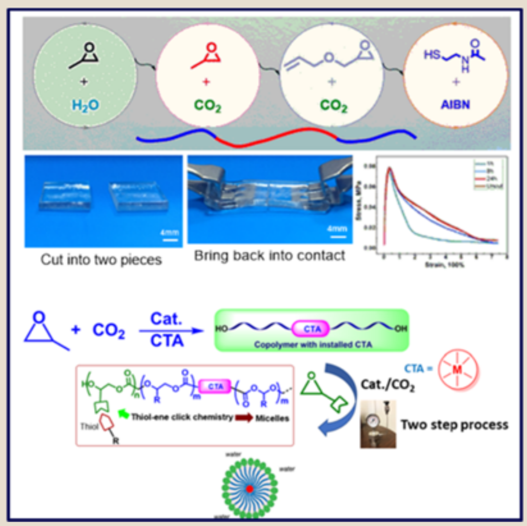


Functionalization of Polycarbonates Towards Desired Applications

Donald J. DARENSBOURG
Chemistry Department

In our laboratory we have a long-standing interest in using CO_2 as a C1 feedstock during the catalytic coupling of epoxides and carbon dioxide to produce polycarbonates. Although tremendous progress has been achieved, the aliphatic characteristics and lack of functionalities of these polymers limit the scope of their application in high value-added and functional materials. Recently we have employed different approaches for introducing functionalization in these polycarbonates which directed their applications in such areas as self-healing materials, micellar catalysis, and as conducting polymers.

Originally inspired from biological muscles, self-healing materials have sparked great interest in polymer chemistry due to their intrinsic potential to deliver products with improved durability, extended lifetime, and maintained structural integrity. Different dynamic chemical and physical interactions have been utilized for making self-healing materials. Among the various self-healing materials being investigated, autonomic self-healing polymers based on H-bonding interactions are desirable due to their mild processing conditions and reversibility as well as no need for an external stimulus. We have developed a one pot three step synthetic strategy involving different catalytic reactions *viz* hydrolysis of epoxides, immortal copolymerization of CO_2/epoxides and thiol-ene click reaction protocol for constructing the first self-healing polycarbonate polymers. Based on the standard tensile testing, these CO_2-based materials showed robust self-healing properties, where the extensibility, maximal strength, and Young's modulus of the specimens can almost entirely recover to their original value under ambient temperature (Macromolecules 2018, *51*, 1308−1313). Very recently we have employed the concept of chain transfer chemistry in these polycarbonates to introduce single metal complexes in their backbone. Furthermore, in a one-pot, two-step synthesis, a second epoxide containing a vinyl substituent can be introduced to afford a triblock ABA polycarbonate, where the metal is contained in the B block. Subsequent to the thiol−ene click chemistry the resulting anionic polymer is shown to self-assemble in deionized water to provide rather uniform, spherical micelles (*Macromolecules* 2019, *52*, 5217−5222; *Organometallics* 2020 asap). Currently we are using these micelles as nanoreactors to perform organic transformation catalytically in aqueous solutions. In order to make conducting polymers we are also currently working on TEMPO based radical polythiocarbonates which are showing promising conductivity values at room temperature.



PTC
POLYMER TECHNOLOGY
MATERIALS SCIENCE & ENGINEERING

Dr. Joseph Baker
PTC Postdoctoral Researcher

Dr. Joseph Baker finished his postdoctoral work in Professor Hung-Jue Sue's lab at the end of February. He officially joined Dr. Sue's research group as a postdoc in January 2018 but also worked along with Dr. Sue since 2015 as part of the APPEAL consortium during his PhD program in chemistry at Texas A&M. As a PhD candidate, his studies involved fundamental chemistry of polyetheretherketone (PEEK) thermoplastic degradation under high temperatures and high pressures with zinc completion fluids. As a postdoctoral researcher Joseph focused on studying viscosity modifier solution behavior with dynamic light scattering and synthetic clay modifications for various applications including nanocomposites. Joseph has begun working as a new product development chemist at Albemarle in Baton Rouge, LA.

Dr. Farhad Daneshvar
PTC Graduate Assistant Researcher—Ph.D. Graduate

Our congratulations to Dr. Farhad Daneshvar for receiving his Ph.D. degree from the Department of Materials Science and Engineering at Texas A&M University. Under the guidance of Dr. Hung-Jue Sue, Farhad has been conducting research on the development of light-weight ultra-conductive materials for subsea power transmission, portable electronics, and energy storage applications.

His research in recent years focused on designing the interface of carbon nanotubes (CNTs) in metals and metal oxides hybrid structures aimed at obtaining enhanced electrical, mechanical and electrochemical properties. During his Ph.D. studies, he has published several papers in high-quality journals related to the field of materials science. Dr. Daneshvar has recently joined Intel at Portland, OR . His work entails developing the of thin-film deposition process for semiconductors and microprocessors.

PTC would like to Congratulate to Drs. Joseph Baker and Farhad Daneshvar in their new jobs and in future endeavors.

WHOOP!

Texas A&M College Of Nursing Allowing Seniors To Fast-Track Graduation To Enter Workforce

Texas A&M University nursing students set to graduate this May will be able to pursue an accelerated graduation plan that allows them the opportunity to quickly enter the workforce to support the state's response to the COVID-19 pandemic.

The College of Nursing informed seniors late last week that they have the option to choose an early conferral of their degree. This comes after Gov. Greg Abbott's recent announcement that he is waiving certain regulations to allow nursing students at the end of their education program and retired nurses to more easily join the workforce as the need for health care professionals continues to soar.

The state will allow temporary permit extensions to graduate and vocational nurses who haven't yet taken the licensing exam. Students in their last semester of nursing school can also complete remaining hours needed to demonstrate their clinical competency via virtual simulations.

"What this did for us is allow an opportunity to confer the degree early and share that conferral with the State Board of Nursing so that they can grant this temporary permit to practice so students could pursue employment as a graduate nurse or offer services in other ways," said College of Nursing Dean Nancy Fahrenwald.

Full story: https://today.tamu.edu/2020/03/31/texas-am-college-of-nursing-allowing-seniors-to-fast-track-graduation-to-enter-workforce/

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Aggie Engineers Create Step-by-Step Method For Making Protective Medical Masks

Emergency room physicians asked Texas A&M's John Criscione for help as supplies diminish.

John Criscione, a Texas A&M professor in the Department of Biomedical Engineering and a Johns Hopkins-educated medical doctor, said he and his colleagues are investigating a low-technology solution to a growing problem. Dr. Criscione and his team have figured out a way to build masks with materials such as air-conditioning filters, sheer curtains, staples and stretchable cords.

John Sharp, chancellor of The Texas A&M University System, said the Texas A&M community has a long tradition of helping society when it needs assistance the most.

"This is exactly the kind of Aggie ingenuity that has been evident on our campus for generations," he said.

Dr. Criscione said his team will be quantitatively testing do-it-yourself masks in the coming days. The team will continue its efforts to create a mask that has features similar to the N95 respirator, which is capable of filtering 95 percent of airborne particles, including viruses.

Full story: **https://today.tamu.edu/2020/03/30/aggie-engineers-create-step-by-step-method-for-making-protective-medical-masks/**

SPE South Texas section

The 2019-2020 SPE student chapter new officers. For information on becoming a member of the SPE student chapter at TAMU, please contact the below officers.

President	Ying-Hua Fu	yinghuafu95@tamu.edu
VP Science	Yue Song	ysong@tamu.edu
VP Engineering	Ming-Uei Hung	muhung@tamu.edu
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Webmaster/Social Media Coordinator	Kasturi Sarang	Kasturi_0402@tamu.edu

Polymer Specialty Certificate Updates

Students that have applied for the Polymer Specialty Certificate	77
Students that have received the Polymer Specialty Certificate	57

For more information, please visit: http://ptc.tamu.edu/polymer-specialty-certificate/

Have Questions?

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PTC POLYMER TECHNOLOGY MATERIALS SCIENCE & ENGINEERING

PTC newsletter prepared by: Isabel Cantu