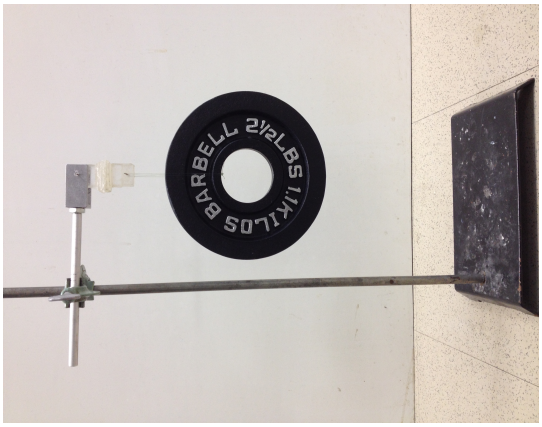
12 Important Research Stories of 2013

Self-Assembly of Stiff, Adhesive and Self-Healing Gels

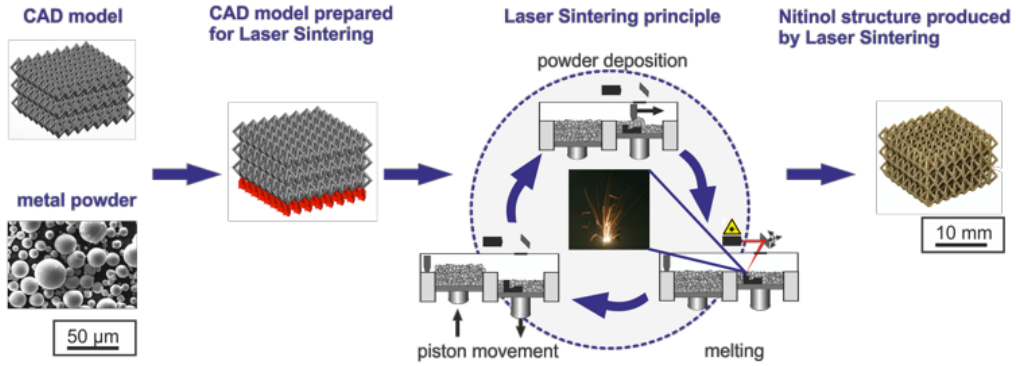
Dr. Yakov Lapitsky and his graduate students, Yan Huang and Patrick Lawrence, have developed new adhesive gels that stick to a wide range of materials, including Teflon, glass and human skin while under water. These gels form spontaneously from low-cost ingredients, can self-heal when torn and redissolve on demand upon changes in the ambient pH. These findings could provide a simple, inexpensive and scalable platform for underwater adhesion and were published in the peer-reviewed journal, Langmuir. The figure shows the bond created by the gel between two 2.5 cm x 2.5 cm Plexiglas plates supporting a weight.



Additional Information: http://www.eng.utoledo.edu/~ylapitsk/

Nickel-Titanium (NiTi) Shape Memory Alloys

Dr. Elahinia's group has conducted studies on the structural and functional properties of Ni-rich nickel-titanium (NiTi) shape memory alloys (SMA) produced by additive manufacturing (AM). Due to challenges in conventional processing of NiTi, near net shape technologies such as AM provide attractive potential for producing highly complex NiTi parts for medical devices. The group has shown the influence of subsequent heat treatments on mechanical characteristics, phase transformation behavior, phase transformation temperatures, pseudoelasticity and cyclic stability of additively manufactured NiTi. For the first time they have shown how to establish and improve pseudoelasticity in NiTi samples prepared by the AM technique Selective Laser Melting (SLM). The groups has successfully shown that SLM provides a promising processing route for the fabrication of high quality pseudoelastic NiTi parts.



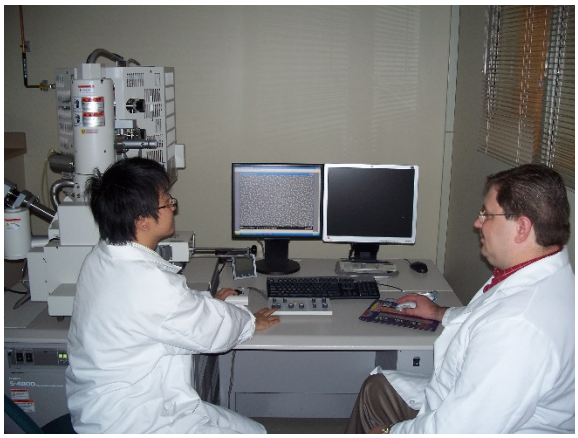
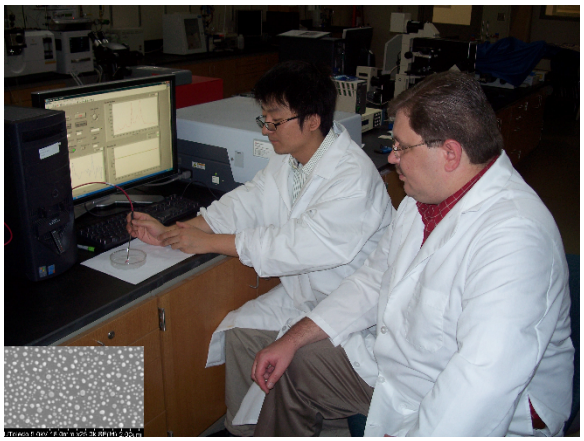
Additional Information: http://smartsys.eng.utoledo.edu/index.html

Green Stormwater Practices

In recent years, it has become increasingly important for communities to create a sustainable infrastructure which can adapt to the changing weather patterns associated with climate change. Extreme precipitation events, often attributed to global climate change, can result in the degradation of valuable assets including infrastructure (buildings, bridges, outfalls) due to flooding and erosive velocities as well as environmental degradation through the carriage of contaminants to recreational waters and drinking water sources. Storm water managers have begun adopting best management practices that address storm water at its source such as impervious surface reduction or bioretention. Dr. Cyndee Gruden, Associate Professor of Civil Engineering, is collaborating with local stakeholders to increase the design, implementation, performance monitoring, and cost-benefit analysis of green stormwater practices. One such project was recently funded by the University of Michigan Water Center.

Additional Information: http://graham.umich.edu/water/projects/tier1

Advanced Diagnostics Sensors for Biomarker Sensing

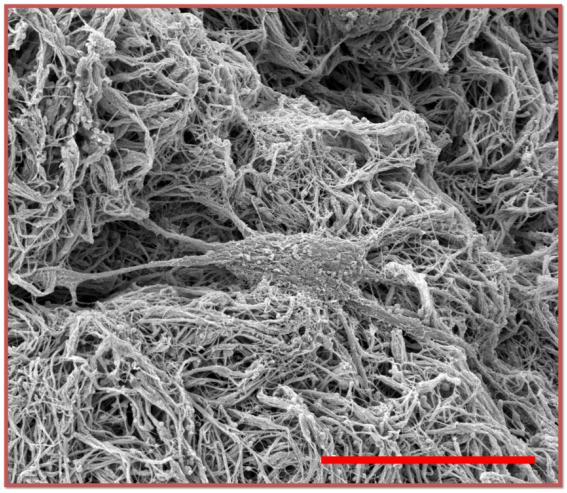
Plasmonic effects of nano-engineered surfaces which are functionalized with highly selective DNA-derived components are being developed by Dr. Brent Cameron, Professor of Bioengineering at the University of Toledo. These surfaces have the potential to lead to robust array-type sensors capable of assessing several biomarkers within a single blood sample or other biological fluid such as saliva, sweat, or urine.
Additional Information: http://eng.utoledo.edu/~bcameron

Carbon dioxide capture

Concerns over the potential for dramatic climate change due to increased carbon dioxide emissions have led the Department of Energy to solicit ideas for carbon dioxide capture from coal-fired power plants. Professor Lipscomb's group is working with Membrane Technology and Research, Inc. to develop a process based on membrane technology. The process using sheets of plastic to selectively remove carbon dioxide from flue gas. Professor Lipscomb and his students are working to improve the efficiency of the process through smart design of the membrane elements.

Additional Information: http://www.netl.doe.gov/File%20Library/events/2013/co2%20capture/R-Baker-MTR-Low-Pressure-Membrane-Contactors.pdf

Injectable Nanofibrous Matrix for Musculoskeletal Tissue Regeneration



An injectable nanofibrous matrix developed by Dr. Eda Yildirim-Ayan, the Director of Engineered Biosystems Laboratory (EBSL), can be used as a delivery vehicle for progenitor cells and proteins in order to promote musculoskeletal tissue repair and function. At EBSL, research team integrates engineering fundamentals, biomimetic design principles, biomanufacturing, and advanced cell biology approaches to improve musculoskeletal tissue health.

Additional Information: www.eng-biosystems-lab.org

Significantly Improved Navigation Systems

Global Positioning System (GPS) and Inertial Navigation System (INS) are complementary technologies for land vehicle navigation. While standalone GPS undergoes signal outages from time to time, standalone INS accuracy deteriorates with time (e.g. especially when INS is built using low cost sensors). Researchers at The University of Toledo headed by Dr. Vijay Devabhaktuni are developing science for integrating GPS and INS data for accurate, continuous, and reliable navigation even during GPS outages. This research continues to receive high attention from the US government (e.g. department of defense).

Additional Information:
http://www.eng.utoledo.edu/eecs/faculty_web/~vdevabhaktuni/

Renewable Fuels and Products

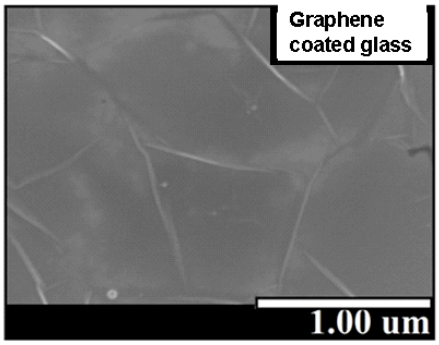
Drs. Sridhar Viamajala and Sasidhar Varanasi are leading a team of researchers from The University of Toledo, University of North Carolina and Montana State University, on project that focuses on high lipid-producing native alkaliphilic algae, which are less susceptible to detrimental contamination (due to their extreme growth environment) and able to accumulate large amounts of lipid. In addition, we will develop and test low-energy options for cell harvesting as well as for fuel and high value product generation. Through integration of transformational and robust advances in algal culture stability and productivity as well as research targeted on the critical processes of algae harvesting and conversion of biochemicals, we propose to develop and integrate scalable, environmentally and economically acceptable processes to produce renewable fuels and chemicals.

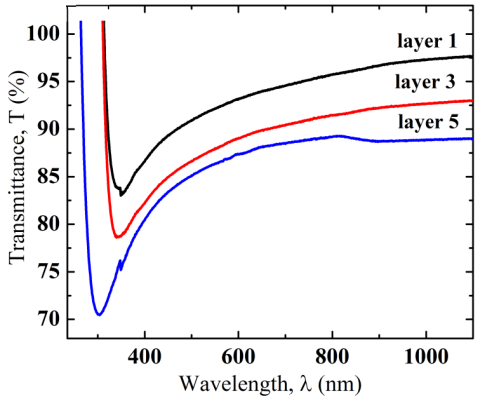
Additional Information: http://www.che.utoledo.edu/viamajala.htm

Towards High Performance Solar Cells using Graphene

Photovoltaic energy conversion attracted renounced attention in the recent past. For the development of solar cells requires not only new device

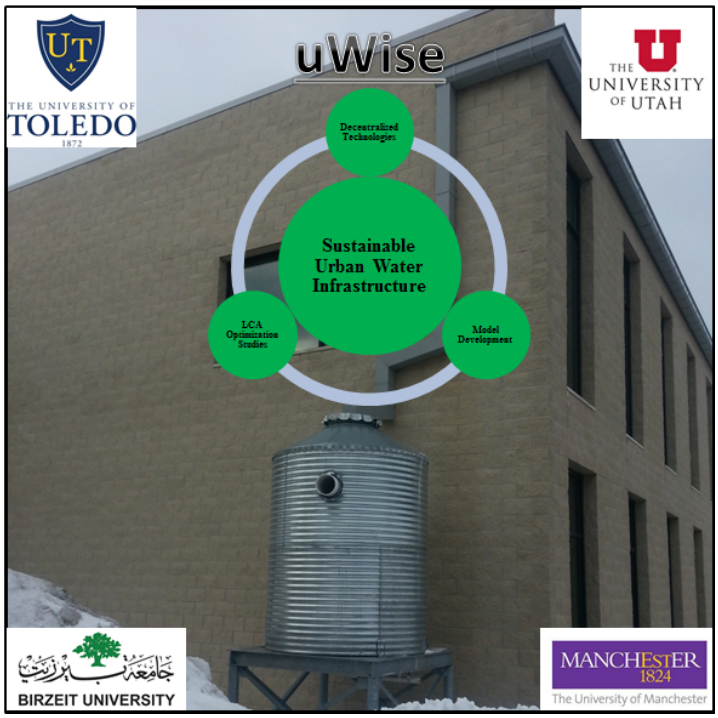
architectures but also new materials and techniques. Dr. Jayatissa and his PhD student Madhav Gautam developed a new solar cell back contact material using graphene. Graphene that has two dimensional carbon flaks will provide a significant improvement in light-weight and efficient solar cells.





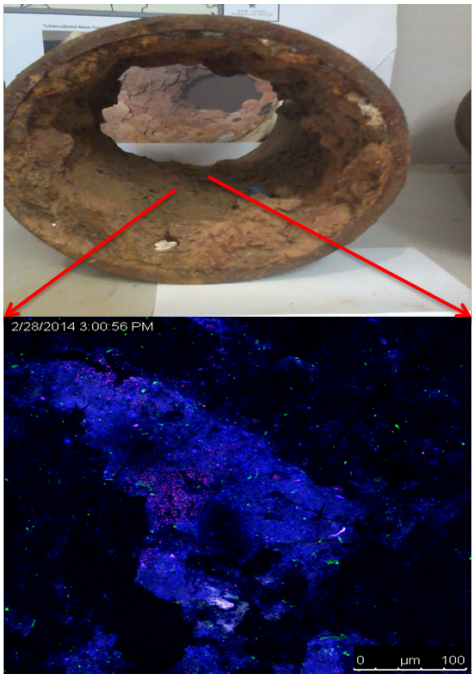
Additional Information:
http://www.eng.utoledo.edu/mime/faculty_staff/faculty/ajayatissa/

uWISE: Urban Water Infrastructure Sustainability Evaluation



The Sustainability Engineering Research Lab, led by Dr. Defne Apul, from the Department of Civil Engineering, University of Toledo, OH is developing the urban water infrastructure sustainability evaluation (uWISE) framework that will compare centralized and decentralized water infrastructure options using the life cycle assessment method. The current focus of the uWISE framework is rainwater harvesting systems. Rainwater harvesting can be used to partially supplement centralized water supply systems, matching the level of treatment to the intended end use, such as toilet flushing. These systems have been evaluated for various building types and research is underway to analyze the sustainability implications of these systems on a larger scale. The University of Toledo currently utilizes a rainwater harvesting system installed on its Research and Commercialization Complex to mitigate peak wet weather flows.
Additional Information:
https://defneapul.wikispaces.com/Water+sustainability

Biofilms in Water Distribution Systems



Dr. Youngwoo (Young) Seo, a researcher at the Departments of Civil Engineering and Chemical & Environmental Engineering, studies pathogenic bacterial biofilm formation and redistribution in aged drinking water distribution systems. Currently, under the supports from the National Science Foundation awards, Dr. Seo aims to provide practical biofilm control methods to water utilities.

Additional Information: http://www.eng.utoledo.edu/civil/seo/seo%20bfrg.htm

World Desalination using Anti-Microbial Materials

Dr. Isabel Escobar is leading a group of researchers from Georgia Institute of Technology and University of Rhode Island, in collaboration with the Jordan University of Science and Technology (JUST) and Morocco's National Office of Electricity and Potable Water (ONEEIEA), on a project to make reverse osmosis membranes embedded with anti-microbial nanoparticles. The project will develop new processes to produce reverse osmosis membranes that resist fouling by microorganisms. The success of this project will improve produced water quality, reduce the cost of the technology to make it more affordable for world regions suffering from water scarcity and energy shortage. The project is funded in the US by the National Science Foundation and internationally by USAID.
Additional Information: http://www.eng.utoledo.edu/~iescobar/