TEXAS TECH UNIVERSITY
College of Engineering™

# enVISION 2008

Texas Tech University | College of Engineering

At the Texas Tech University College of Engineering, we know that one person can change *the world*.

However, when the collective merges to form collaborations from within and between disciplines, that collective can change the *way we envision change*.

# enVISION

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Jeff Sammons, Managing Editor
Dr. Javad Hashemi, Research Editor

Illustrations by Jeff Sammons unless otherwise noted.

# Texas Tech University College of Engineering

## *Message from College of Engineering Dean Pamela A. Eibeck*

**Pamela A. Eibeck, Ph.D., P.E.**

Dear Friends of the College of Engineering:

We are delighted to offer you the opportunity to envision some of the exciting research within the College of Engineering at Texas Tech University.

We are proud of the ground-breaking research that our faculty members are investigating. It is our faculty members' passion for their areas of expertise and the contributions from our dedicated graduate students that results in this exciting research.

You will read about our research in wind energy and petroleum engineering, directly assisting our nation in the fight to gain energy independence.

Texas Tech offers the world's only Ph.D. in wind science and engineering, building on the strong reputation of our experienced wind researchers in the Wind Science and Engineering Research Center. A large donation to our petroleum engineering department from one of our alumni will enable us to increase our petroleum research capabilities and continue to educate quality petroleum engineers.

In a collaboration between our Water Resources Center and our wind researchers, we have embarked on the first desalinization project for an inland municipality.

> "It is our faculty members' passion for their areas of expertise that results in this exciting research."

Our Center for Pulsed Power and Power Electronics is developing potent ways to defeat IEDs that our troops may face in the battlefield.

You will also read about three unique projects in bioengineering, including wireless medical sensors, heart valve studies, and the study of genomic signal processing of cancerous cells.

Finally, we highlight the collaborations of our faculty in the study of advanced materials, including polymers, the effects of high pressure effects on metals, nanoenergetics and explosives, and opto-electronic devices.

Enjoy learning more about how Texas Tech is making a difference for our society…and our world.

Pamela Eibeck

**Pamela A. Eibeck, Ph.D., P.E.**

# *Changing the way you light your home...*

## *College of Engineering Receives $9 Million for Nanophotonics Research*

The College of Engineering is proud to announce a $9 million package-$2 million from the Texas Emerging Technology Fund (TETF), $5.35 million from AT&T, and a $2 million commitment from the university—to attract a team of world-class faculty researchers in the field of nanophotonics.

The collaborative funding will be used to enhance nanophotonics research, and supports the development of new technologies, including those that will influence tomorrow's communications industry.

The $5.35 million from AT&T will establish two endowed chairs, the Edward E. Whitacre, Jr. Chair in Electrical and Computer Engineering and the Linda F. Whitacre Chair in Electrical and Computer Engineering. Drs. Hongxing Jiang and Jingyu Lin, formerly professors at Kansas State University, now fill the positions.

"Continuing excellence in research is one of the strategic aims of the Texas Tech University System," said Texas Tech Chancellor Kent Hance.

Drs. Jiang and Lin have more than 185 publications, eight U.S. patents, 14 patents pending, and receive an average of $1.5 million in competitive funding annually related to the study of nanophotonic devices.

The research has significant implications for defense systems and applications, telecommunications, homeland security, and the future of commercial and residential lighting. Nanophotonic devices have the potential to revolutionize light sources, resulting in enormous energy savings to the nation.

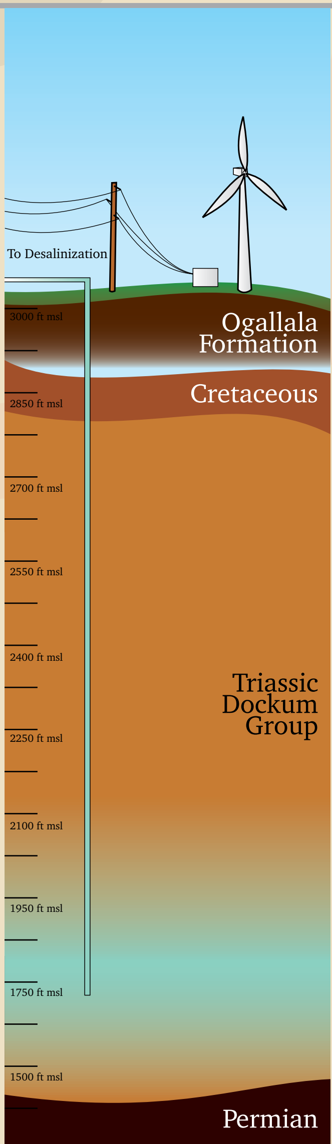
At Gov. Perry's request, the Texas Legislature established the TETF in 2005 to enhance the research and commercialization of emerging technologies in Texas. TETF will help Texas Tech establish a first-class research team in the highly competitive area of nanoscale opto-electronics. Opto-electronics is the science and engineering of converting light energy into electrical energy, and vice versa.

"Texas Tech already conducts groundbreaking research in nanoscale opto-electronic materials," said Eibeck. "Yet bringing these new professors to Texas Tech, along with their research teams, and dramatically growing our university's capabilities through the combined efforts of the TETF, AT&T, and the university, will firmly place us at the head of the pack in this promising field."

> "Texas Tech already conducts groundbreaking research in nanoscale opto-electronic materials, yet bringing these new professors will firmly place us at the head of the pack in this promising field."
>
> — DEAN PAMELA A. EIBECK


**Texas Governor Rick Perry Announces Funding for Nanophotonics Research at Texas Tech University**

# *Turning desert winds into drinking water...*




## *Wind Science and Engineering Research Center Pilots Desalinization in West Texas*

The Texas Tech University Wind Science and Engineering Research Center (WISE) in conjunction with the Texas Tech University Water Resources Center have collaborated through a $500,000 state grant to bring drinking water to West Texas citizens, in a green way.

The grant, from the Office of Rural Community Affairs (ORCA) Renewable Energy Demonstration Pilot Program, will help fund the $1.07 million project.

The partnership between ORCA, Texas Tech and Seminole is the first project in the United States to use wind power to desalinate drinking water for an inland municipality.

Seminole currently draws its drinking water from the Ogallala Aquifer, which is rapidly being depleted. The small town has no access to surface water supplies.

Pumping water from the brackish Dockum Aquifer (also known as the Santa Rosa Aquifer), which lies deep beneath the Ogallala, has not been an option because desalinating the water has been cost prohibitive.

The ORCA grant will allow the installation of a 50-kilowatt wind turbine to power a reverse osmosis plant.

Seminole, a city of more than 6,000 people in Gaines County, about 80 miles southwest of Lubbock, currently uses about two million gallons a day on average from the Ogallala Aquifer. The wind turbine in the pilot project will provide the electricity for a reverse osmosis plant that, depending on the aquifer characteristics, will produce up to 30,000 gallons per day of drinking water for the city.

> The partnership between ORCA, Texas Tech and Seminole is the first project in the United States to use wind power to desalinate drinking water for an inland municipality.

**Modern Wind Farm**

# *They're not just chasing after the wind...*

## *Doctor of Philosophy in Wind Science and Engineering*

The Wind Science and Engineering (WISE) Research Center at Texas Tech University was founded in 1970s when a tornado swept through the city of Lubbock. The center was subsequently established to pursue multidisciplinary research in wind-related science and engineering.

Today, the center integrates 11 academic departments, 37 faculty affiliates, seven graduate students, and 19 National Science Foundation/ Integrated Graduate Education Research and Training fellows.

A multidisciplinary doctoral degree program provides students with the opportunity to integrate various aspects of the wind science and engineering program into one graduate degree. Students take a systematic approach to wind hazards and wind energy research while collaborating with internationally recognized faculty in ongoing center research as well as their own research projects.

"Wind is an environment that will always be with us," said Dr. Kishor Mehta, P.W. Horn Professor of Civil Engineering, National Academy of Engineering member, and visionary behind the new program. "There are problems related to wind that have yet to be tackled. At the same time, wind is a resource with unrealized potential. This Ph.D. integrates the science of windstorm damages and developing wind energy systems so that our graduates come out with a stronger understanding of how those sciences interrelate."

For more information visit the WISE Research Center Web site at www.wind.ttu.edu.

> This Ph.D. integrates the science of windstorm damages and developing wind energy systems so that our graduates come out with a stronger understanding of how those sciences interrelate."
>
> — DR. KISHOR MEHTA

# *Shaping the future of petroleum engineering education...*

## *College of Engineering Receives $15M to name Petroleum Engineering Department*

The Texas Tech University College of Engineering has accepted a $15 million donation from alumnus Bob L. Herd to the petroleum engineering

The funds will be used to endow the department. Herd's donation will result in the first naming of an academic

> "He set a high standard for others to give to the industry as well as back to Texas Tech."
>
> — DR. LLOYD HEINZE

department on campus, the Bob L. Herd Department of Petroleum Engineering.

Herd, a 1957 petroleum engineering graduate, is the founder and operator of Herd Producing Company in Tyler. He was named a Distinguished Engineer in the College of Engineering in 1995 and was recognized as a Texas Tech Distinguished Alumnus in 1994. Herd credits Texas Tech for his success.

"My family and I are pleased we are able to help Texas Tech provide the educational foundation for future petroleum engineers like it provided me many years ago," Herd said. "It was this education that made this donation possible."

"We are proud of the exceptional success of our alumnus in the petroleum industry," said Pamela Eibeck, dean of the College of Engineering. "His generosity is transformative and will allow the program to provide one of the nation's best quality petroleum engineering educations to our students into the future. We are truly grateful for his willingness to give back to the petroleum engineering department."

"He set a high standard for others to give to the industry as well as back to Texas Tech. We are proud to call him one of our Distinguished Engineers," said department chair Dr. Lloyd Heinze.


(L-R) Guy Bailey, Texas Tech president; Lloyd Heinze, chairman of the Bob L. Herd Department of Petroleum Engineering; Pam Eibeck, dean of the College of Engineering; Kent Hance, Texas Tech chancellor; Bob L. Herd; Pat Herd; Michael Herd; and Kelli Herd.

# *Field research laboratories... in our own back yard...*

Texas Tech University's Red Raider#1 Test Well

## *Petroleum Engineering Research*

The Texas Tech University Bob L. Herd Department of Petroleum Engineering has taken pride in contributing technical solutions to enhancing the production of oil and gas in the Permian Basin and similar areas around the world.

Toward that end, our faculty are pursuing work in advanced drilling methodologies.

> "Approximately 67 percent of the nation's petroleum resources are located within 200 miles of the Texas Tech campus"
>
> — DR. LLOYD HEINZE

The College of Engineering owns a 4000-foot deep test well within 20 minutes of the Texas Tech campus. This well will continue to play a role in production operation studies for petroleum engineering students.

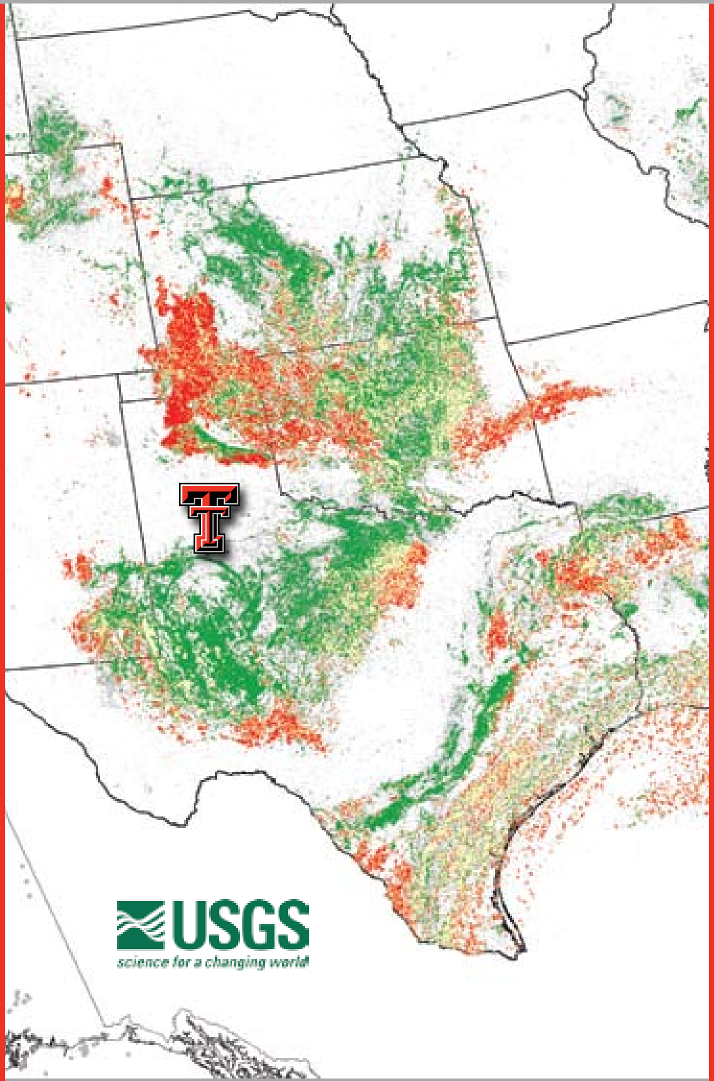
Red Raider #1, the largest test well of its kind on a university campus, is a field laboratory for students to examine an on-site pumping unit, explore and test other methods of artificial lift, and study fluid flow.

Texas Tech's location offers a unique environment for studying existing wells, fields and reservoirs as approximately 67 percent of the nation's petroleum resources are located within 200 miles of the Texas Tech campus.

Over 100,000 wells in West Texas and the Permian Basin offer students access to a rich history of successful and unsuccessful implementations of techniques and recovery methods.

These methods include assorted artificial lift devices, water-flooding, $CO_2$ injection, and other techniques. Permian Basin well depths range from 1000 feet to 12,000 feet, and represent a variety of reservoir characteristics.

Texas Tech produces 10 percent of the U.S petroleum engineering graduates each year.




U.S. Oil and Gas Wells

# *Defeating IEDs with unimproved devices...*

## *The Center for Pulsed Power and Power Electronics*

Military forces are faced with new and unpredictable enemy attacks in the battlefield every day. The Center for Pulsed Power and Power Electronics utilizes its expertise in generating very high power electrical pulses to provide troops on the battlefield with effective, innovative technology. This effort is complemented by investigating the physical phenomena associated with pulsed high voltage.

> "The Center for Pulsed Power and Power Electronics utilizes its expertise in generating very high power electrical pulses to provide troops on the battlefield with effective, innovative technology."

These devices can be integrated into standard weapons systems with the purpose of disabling enemy electronic systems, such as Improvised Explosive Devices with a minimum of collateral damage.

Texas Tech University engineers and scientists develop compact, repetitive, high voltage generators that can drive a wide range of devices and systems for military applications. These devices and systems include directed energy devices, electronic jammers, electronic upset devices, car immobilizers, and non-lethal crowd control systems.

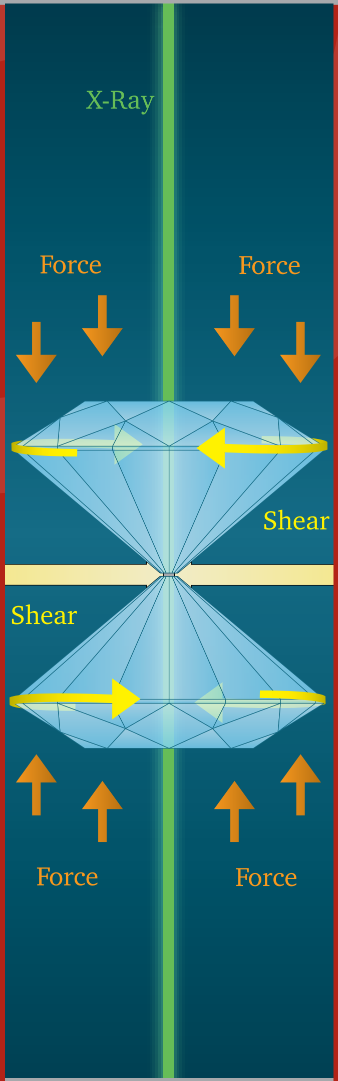
The P3E center faculty members include nine full-time faculty members, nine support staff, and 23 graduate students.

Faculty from the center have had articles published in *IEEE Transactions on Plasma Science*, *Journal of Applied Physics*, *IEEE Transactions on Magnetics*, and *IEEE Transactions on Dielectrics and Electrical Insulation*, and have published more than 20 books.

The center has received funding from the US Army Space and Missile Defense Command, the Department of Energy, the Air Force Office of Scientific Research, Sandia National Labs, the Office of Naval Research, Lockheed Martin Corporation, and Northrop-Grumman Marine Systems.


**Pulsed Power Device Testing**

# *Under pressure...*
# *of the Earth's core...*



Rotational Diamond Anvil Cell

## *Rotational Diamond Anvil Cell*


*Dr. Yanzhang Ma*
*ASSOCIATE PROFESSOR, MECHANICAL ENGINEERING*


To understand how various materials react to extreme conditions, scientists use a device called a diamond anvil cell to generate ultra-high pressures and temperatures more than 3,000,000 atmospheres (3 megabars) and 7000° Kelvin. The device has the power to recreate the pressure-temperature conditions of the center of the Earth.

This capability has been utilized to explore the existence of new materials that are not observed under normal conditions and to measure the engineering properties of materials under extreme pressure and temperature and large plastic shear.

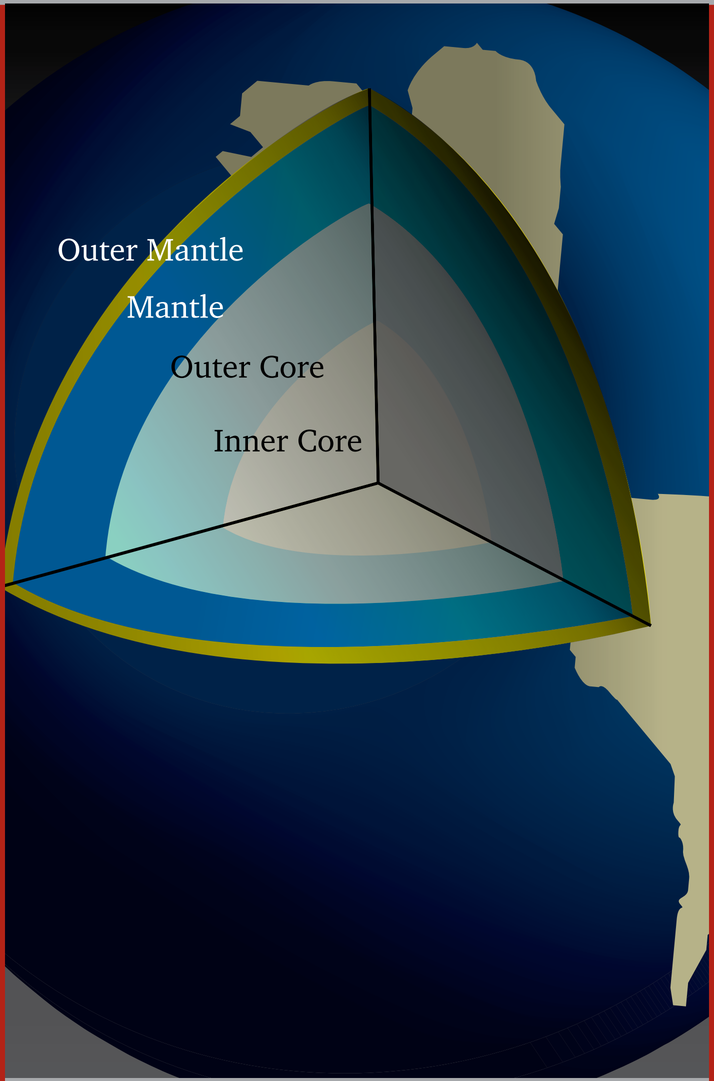
Dr. Yanzhang Ma has established the High Pressure Materials Laboratory in the Department of Mechanical Engineering with the support from the National Science Foundation (NSF). The research laboratory has the capability to create pressure and temperature of over 1 megabar and 7000 Kelvin, while performing in situ spectroscopic measurements of a material.

Ma was the first to recreate both the pressure and temperature of the Earth's core conditions for in situ X-ray measurements. He determined the temperature at the center of the Earth's core to be approximately 6000° Kelvin.

Ma was the only researcher in the United States to apply large shear to materials under ultra-high pressures with a device called a rotational diamond anvil cell. His research results indicate that plastic shear plays an very important role in the formation of a high pressure material. The shear can substantially reduce the transformation pressure and thus significantly reduce the cost of material production in industry.

Ma collaborates with the Argonne National Laboratory, Brookhaven National Laboratory, and Oak Ridge National Laboratory. At Texas Tech, Professor Ma collaborates with Drs. Jharna Chaudhuri, Alan Jankowski, and Zhaoming He from mechanical engineering and Dr. Guigen Li from the chemistry and biochemistry.

He has received funding from NSF, the Department of Energy, and the Army Research Office.



The Earth's Inner Core Pressure, Believed to be 330 - 360 GPa

Underwater Reaction of Aluminum and Polytetrafluoroethylene

## Nanoenergetics and Melt Dispersion Theory

**Dr. Michele L. Pantoya**
ASSOCIATE PROFESSOR, MECHANICAL ENGINEERING

Traditional explosive materials such as fireworks and gunpowder do not require oxygen to explode and can explode underwater or even in a vacuum.

These explosions are called energetic reactions, and are very different from large, powerful explosions. However, with a small amount of an energetic material, a potent reaction or an explosion can occur.

Dr. Michelle Pantoya examines energetic diffusion reactions at the nanoscale and she is discovering that previous assumptions about how these reactions occur have been inaccurate. She has discovered that the way that the reaction takes place with nanoscale particles are different from how it takes place with larger-sized elements.

In collaboration with Dr. Valery Levitas, Pantoya's research has demonstrated that the flame rate of the reactions can be three orders of magnitude greater at the nanoscale than at larger scales.

Pantoya is working to understand how and why the reactions are so different at the nanoscale. This information will lead to the creation of more efficient energetic materials.

As more and more efficient energetic reactions are engineered through Pantoya's research, the energy release from the reaction could allow such energetic materials to be used as advanced propellants for outer space microthrusters or as a solid fuel for aeronautical or astronautical implementation.

> "Dr. Michelle Pantoya examines energetic diffusion reactions at the nanoscale, and she is discovering that previous assumptions about these reactions have been inaccurate."

Her research has already revealed a new mechanism for energetic reactions. This mechanism is called the melt dispersion theory.

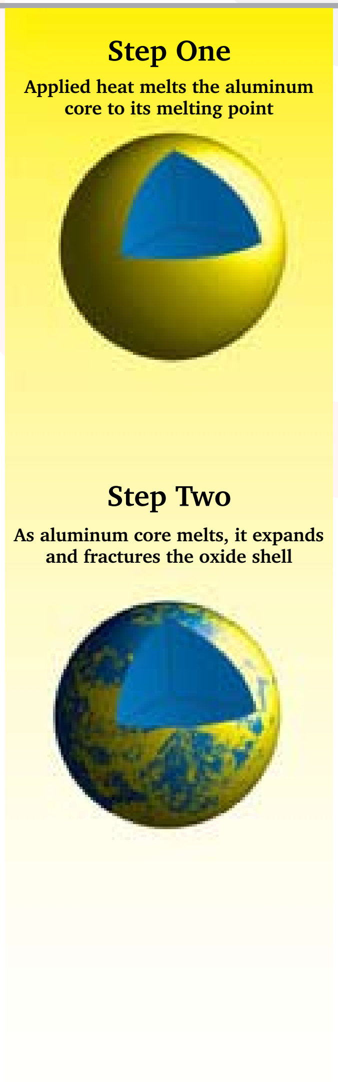
Traditional diffusion reactions can be as short as one second. However to achieve more intense explosions, the reaction needs to be as short as 10 microseconds. A faster reaction time is not possible in diffusion reactions, but is highly possible in melt dispersion reactions.

In some cases, new alloys and materials are also created during the diffusion reactions. These products that are created can sometimes be considered new or transformative materials.

Pantoya collaborates with Drs. Brandon L. Weeks, Iris V. Rivero, and Sindee L. Simon at Texas Tech University. Externally, she collaborates with the Dr. Valery Levitas at Iowa State University, the Army Research Laboratory, Indian Head NSWC, Los Alamos National Laboratory, and Idaho National Laboratory.

Pantoya's research has been published in *Combustion and Flame*, *Applied Physics Letters*, *Journal of Propulsion and Power*, and *Thermochemica Acta*.

Funding for her projects has come from the National Science Foundation, the U.S. Army Research Office, the Office of Naval Research, and the Los Alamos and Sandia National Laboratories.




Melt Dispersion of Alumina Shell and Aluminum Core

# Understanding how explosives explode...


## Organic Explosives


### Dr. Brandon L. Weeks
ASSOCIATE PROFESSOR, CHEMICAL ENGINEERING


The conventional explosions that we see on the television or in movies are generally explosives such as dynamite or TNT.

These explosive materials are used in construction, mining, and military applications, along with a variety of other applications. People have manipulated similar materials for more than 2,000 years.

Scientists and engineers continue to study organic explosives to create more efficient and more powerful reactions.

Dr. Brandon Weeks is attempting to understand how these materials react at the nanoscale so that scientists and engineers can make correlations to how they react at the microscale.

Additionally, Weeks examines the microscale properties of explosive materials to understand why reactions take place. The properties that he examines include the crystal growth shapes and morphology.

The shape and morphology of these materials can be modified and in some cases, with modifications, the reactivity of the material can change as the crystal growth changes.

In this way, an explosive material can be created that is much less sensitive to heat, making the material safer to handle, and less likely to explode at an undesirable time. Many applications exist for these materials.

The changes in the crystal growth can be achieved by adding specific impurities or by changing the size, shape, and spacing of crystals.

Weeks collaborates with Drs. Michelle Pantoya, Greg McKenna, and Sindee L. Simon at Texas Tech University. Externally, he collaborates with William King University of Illinois and Michael Silevitch at Northeastern University.

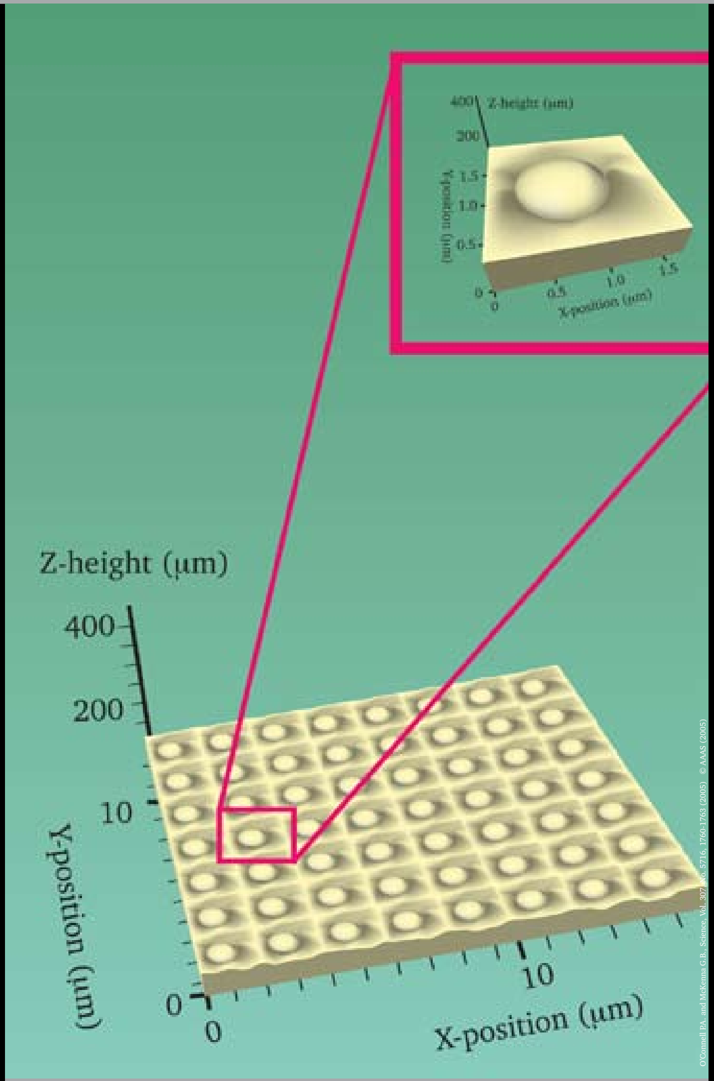
Weeks' research has been published in *Propellants*, *Explosives and Pyrotechnics*, *Journal of Crystal Growth*, *Journal of Physical Chemistry B*, and *Nano Letters*.


He has received funding from the National Science Foundation, the Lawrence Livermore National Laboratories, the Department of Homeland Security, and the Office of Naval Research.


**0.3 Pounds of Explosive in 24 Inches of Water**

**10 Pounds of Ammonium Nitrate**

# Constructing better polymers...




Nanorheology Through Nanobubble Analysis

## The Glass Transition and Polymers


**Dr. Gregory B. McKenna** PAUL WHITFIELD HORN PROFESSOR AND JOHN R. BRADFORD ENDOWED CHAIR IN ENGINEERING, CHEMICAL ENGINEERING

**Dr. Sindee L. Simon** PROFESSOR, CHEMICAL ENGINEERING


Our world would be very different without polymers. In wood, proteins, vehicles, electronics, and airplanes, polymers play a key role in our daily lives and will play an even larger role in future technological advances.

To create polymers that meet the changing needs of society, it is necessary to gain a better understanding of how they are created, how they change, and how they are constructed.

Drs. Greg McKenna and Sindee Simon are studying polymers at the macro, micro, and nanoscale, and many of their results are very suprising.

McKenna is looking for answers in two characteristics of polymers, the fundamentals of the glass transition ($T_g$) and the rheology, or how polymers act and react under the influence of an applied stress.

McKenna's group has pioneered new experiments with an atomic force microscope to investigate the influence of material size and shape on how polymers react. Thin films are viewed in the microscope to study how temperature, viscosity, elasticity, and film thickness interrelate.

These responses are solicited by inflating nanobubbles, a measurement method that allows McKenna to change each of the variables systematically.

These results could lead to the creation of polymers with properties that were previously not achievable.

Simon is examining the structural recovery of polymers as they cool below their $T_g$. Her research efforts are able to be accomplished because of the unique volume dilatometers at Texas Tech University. The dilatometers in Professor Simon's laboratory are among the most accurate in the world, having a resolution of 0.4 x $10^{-5}$ $cm^3/g$.

This research work has proven that the current understanding of structural recovery of polymers relies on an incorrect assumption.

Simon has also become one of the world leaders in understanding and developing models of how the physical and mechanical properties of thermosetting materials change during curing.

Simon's polymer models could be used to create very light spacecraft that withstand the temperatures of outer space while offering superior fire resistance.


McKenna's nanotechnology work has been funded by the U.S. Army Research Office and the National Science Foundation. The U.S. Department of Energy, the Office of Naval Research, NASA and the American Chemical Society's Petroleum Research Fund also support the group activities.


McKenna's recent research has been published in *Science*, *Physical Review Letters*, *Macromolecules*, *Journal of Chemical Physics*, *Physical Review B*, *Journal of Polymer Science Part B. Polymer Physics Edition*, *The Journal of Non-Crystalline Solids*, and *Polymer*.

Simon's research has been published in *Journal of Applied Polymer Science*, *Polymer*, *Journal of Polymer Science: Part B: Polymer Physics*, *Journal of Non-Crystalline Solids*, *Macromolecules*.


She currently is the lead principal investigator on grants from the National Science Foundation, the American Chemical Society Petroleum Research Fund, NASA, and the Texas Higher Education Coordinating Board Advanced Research Program.


Graduate Students Prepare a Volume Dilatometer

# Coding safety in outer space...

## SequenceL

**Dr. Daniel Cooke**
PAUL WHITFIELD HORN PROFESSOR, COMPUTER SCIENCE

When the Space Shuttle or the CEV is launching, problems could arise that would require the spacecraft to abort the mission. In such a case, it would be difficult for astronauts to quickly identify the best solution. The spacecraft could abort to a low orbit, abort to Kennedy Space Center, or dozens of other locations on the East coast and overseas. Each abort location would offer various benefits and detriments.

Combining the guidance and control systems with the Shuttle Predictor Code allows the SequenceL-generated code to identify the best location to abort to and the best time to abort.

Dr. Daniel Cooke's language, SequenceL, has been applied to the Shuttle Predictor Code, a system that constantly predicts the altitude and velocity of a spacecraft for the next two seconds.

Combining the guidance and control systems with the Shuttle Predictor Code allows the SequenceL-generated code to identify the best location to abort to and the best time to abort.

SequenceL is a simple declarative programming language that capitalizes on two computational laws that Cooke discovered.

Cooke is working with NASA to integrate SequenceL flight code into future Mars, moon, and orbital missions.

Cooke's research has been published in COMPUTER, Software Practice and Experience, Science of Computer Programming, Annals of Software Engineering, ACM Transactions on Programming Languages and Systems, and Annals of Mathematics and Artificial Intelligence.

Research funding has come from NASA, the U.S. Department of Agriculture, the United Space Alliance, and the Department of Defense.

He received the IEEE Computer Society's Technical Achievement Award for his work on SequenceL.


NASA Constellation Project:
Orion with a Lunar Lander

## Answer Set Programming

**Dr. Michael Gelfond**
PROFESSOR, COMPUTER SCIENCE

As NASA scientists and engineers develop spacecraft that travel greater and greater distances into our galaxy, greater autonomy is needed in the spacecraft and systems.

NASA scientists need a system that quickly finds work-around plans in response to multiple failures within the spacecraft.

In future missions, both manned and unmanned, the integration of Dr. Michael Gelfond's language, Answer Set Prolog (ASP), will provide NASA Mission Control and astronauts a solution when unexpected problems arise.

Working either with or without human intervention, his ASP-based system could react to an unexpected event.

The system contains a knowledge base, written in ASP, which contains technical information about the Space Shuttle, as well as common sense information needed to make necessary decisions.

Even if multiple problems arise, the system would identify the best solution for the problem by analyzing stored axioms and inference rules. An astronaut could identify the solutions that the system presents, or mission control could have the solution implemented automatically.

More than 20 years ago, Gelfond, in collaboration with Vladimir Lifschitz, developed Answer Set Prolog. This work formed the foundation of new methodology called Answer Set Programming (ASP) for knowledge representation and for solving difficult reasoning problems.

At Texas Tech, Gelfond collaborates with Drs. Marcello Balduccini, Richard Watson, Nelson Rushton, Yaunlin Zhang, and Dan Cooke.

Externally, he closely collaborates with Vladimir Lifschitz from the University of Texas at Austin, Chitta Baral from Arizona State University, Tran Cao Son from New Mexico State University, and Nicola Leone and Piero Bonatti from Italy.

Gelfond's research has been published in *Theory and Practice of Logic Programming*, *Artificial Intelligence*, *Journal of Logic Programming*, *Journal on Software and Knowledge Engineering*.

He has received funding from the National Science Foundation, National Aeronautics and Space Administration, iDARPA, and the United Space Alliance.

*Hate going to the doctor's office?*
*Just text him your vital information...*

## Monitoring Vital Signs: Wireless Medical Sensors


### Dr. Donald Y.C. Lie
ASSOCIATE PROFESSOR AND KEH-SHEW LEW REGENTS CHAIR, ELECTRICAL AND COMPUTER ENGINEERING


Patients in a hospital generally have the luxury of quickly accessing expensive and specialized equipment to monitor their health.

However, when a patient is away from the hospital, constant monitoring may not be available. In situations like this, wireless wearable or non-contact sensors could provide a patient a high level of medical attention, without significant inconvenience.

In the future, integrated circuit (IC) devices could be employed in both healthy and sick individuals. Patients could receive a full-spectrum of health monitoring while at work or in the comfort of home.

Devices with this capability have not been available in the past, as the creation of small units that consume very little power while providing strong and consistent communication was not possible.

With advances in nanoengineering, digital signal processing (DSP), wireless technology, and power storage, wireless monitoring is a reality.

Real-time monitoring of epilepsy patients through implanted or scalp-mounted devices could provide medical professionals with an accurate medical history of a patient to assist in the prediction of seizures and episodes.

The Texas Tech University Department of Electrical and Computer Engineering is working with the Department of Animal Sciences and the Texas Tech University Health Sciences Center (TTUHSC) to develop prototypes of these IC devices for usage as wireless medical sensors.

> "Texas Tech University has the unique capability of designing and building devices... with on-campus cooperation between doctors, biologists, and engineers."
>
> — DR. DONALD Y.C. LIE

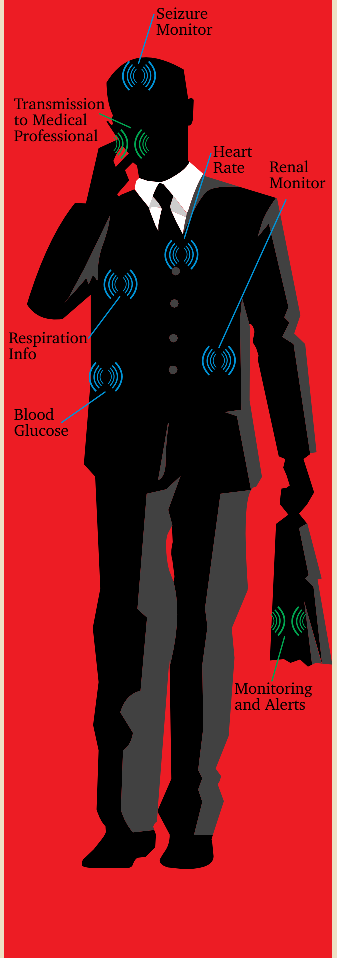
According to Dr. Donald Lie, "Texas Tech has the unique capability of designing and building devices to meet these needs with on-campus cooperation between doctors, biologists, and engineers. Where other universities might have to look at testing this device with another organization, we can stay on campus and test the devices with animals in conjunction with our animal sciences facilities.

"In collaboration with our on-campus health sciences center, we can send the device through FDA testing and integration with local patients. This 'full circle' process within our university has significant benefits for the creation of new devices and for the end user."

The next time you need an antibiotic, that prescription may only be a text message away.

At Texas Tech and the TTUHSC, Lie collaborates with Drs. Ron Banister, Tim Dallas, Andrew Dentino, Sharmila Dissanaike, John Griswold, Herb Janssen, K.J. Oommen, and Y. Zhang

His research has been published in IEEE's *Journal of Solid-State Circuits*, *Transactions on Microwave Theory*, *Transactions on Circuits and Systems – I (TCAS-I)*.




**Future Wireless Biomicroelectronic Monitoring Network**

*Sometimes, heart surgeons*
*need an engineer's advice...*

## Suturing the Heart Valve: The Right Way


### Dr. Zhaoming He
ASSISTANT PROFESSOR, MECHANICAL ENGINEERING


When a patient has a heart valve problem, doctors rely on precedents and previous results to determine the appropriate treatment. In many cases, the best treatment may be taken, but without studying the mechanics of a patient's heart, it is difficult for a surgeon to know if the optimal procedure will be performed on a particular patient.

Dr. Zhaoming He is examining the solid, tissue, and fluid mechanics of hearts, heart valves, artificial hearts, and other medical devices. The mechanical perspective of how heart diseases or other heart defects, affect these organs and medical devices can greatly benefit the medical community.

He also looks at how variables in a procedure can be optimized. These variables may include the nature of the surgery, whether it is an "open" surgery, where the rib cage is separated and opened, or whether it is a percutaneous procedure. Historically, many doctors have recommended the replacement of a heart valve for severe cases of mitral valve regurgitation.

The replacement of the valve may be the best available treatment for some patients, but the existing heart valve may remain viable for many patients and the complications of the replacement surgery can be severe. Valve repair is preferred

> "Without studying the mechanics of a patient's heart, it is difficult for a surgeon to know if the optimal procedure will be performed on a particular patient."
>
> — DR. ZHAOMING HE

for a small number of traumas and complications.

Utilizing a grant from the American Heart Association, Dr. He is currently studying the nature of a mitral valve procedure called "Edge-to-Edge Repair." This surgery involves the insertion of sutures to "assist" a valve that does not fully close. When the mitral valve does not fully close, a small amount of blood can pass from the ventricle back into the atrium.

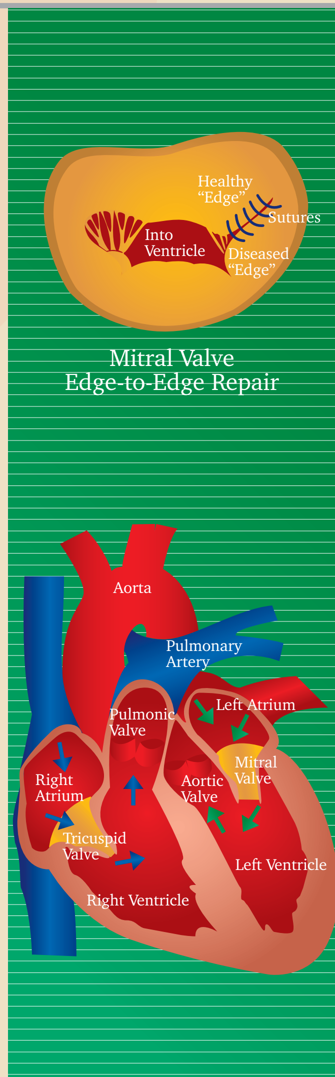
When a surgeon sutures the edges of two leaflets of the mitral valve, these sutures can assist mitral valve leaflet coaptation. Therefore, the "edge-to-edge" repair prevents future regurgitation of blood.

The manipulations that are made to the heart valve alter its geometry and mechanics, even the left ventricle filling function. Using pigs as test subjects, Dr. He and his team study the effects of the procedure on the heart, and make recommendations to surgeons on the best practices for the surgery.

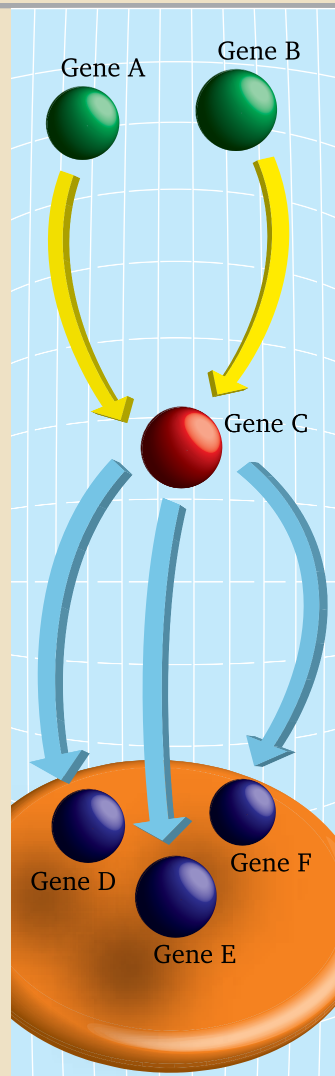
Dr. He collaborates with the University of Connecticut in the area of heart valve modeling.

His research has been published in *Journal of Biomechanics*, *Journal of Biomechanical Engineering*, *Journal of Heart Valve Disease*, *Annals of Thoracic Surgery*, and *Journal of Cardiovascular & Thoracic Surgery*.

External funding of his work has come from the American Heart Association.




**Cardiovascular Biomechancial Analysis**




**Genetic Network**



## *Cancer Cell Communication: Gene Communication Networks*

*Dr. Ranadip Pal*
*ASSISTANT PROFESSOR, ELECTRICAL AND COMPUTER ENGINEERING*

Biologists and engineers are discovering that cancer cells communicate in a way that is not unlike our own telecommunications systems. Through this knowledge, doctors can now more easily defeat cancer within patients.

By understanding the cancer's communications network, doctors can intervene in the cancer with time, dosage, and location variances.

This therapy involves the creation of a cancer-specific and patient-specific modification to the cancer network, minimizing side effects.

Instead of dealing with cancerous areas with a broad and destructive approach like radiation or chemotherapy, this therapy identifies weaknesses or particular characteristics of the gene network in a patient, and targets the undesirable aspects with control.

Dr. Ranadip Pal, assistant professor of electrical and computer engineering, indicates, "There is a similarity between human designed systems and the biological systems, even though the complexity of the biological systems is much higher. For instance, we can find an analogy between what we have learned in telecommunications and in the formation of genes from the four DNA bases.

"Similarly, common patterns found in engineering systems

> "We can find an analogy between what we have learned in telecommunications and in the formation of genes from the four DNA bases."
>
> — DR. RANADIP PAL

and biological systems provide us an approach to unearth biological relationships utilizing techniques of signal processing and control."

By combining biological knowledge with engineering approaches and knowledge, gene and protein expressions can be analyzed to identify how the cancer network works.

Data from cancerous and normal human cell lines and mice tissues are collected using microarray, or green fluorescence protein procedures. This data is then analyzed to identify the optimal treatment for a specific patient. The individualized control can prevent reactions.

The development of large communication networks that Alexander Graham Bell brought to humans is now helping humans defeat tiny cancer communication networks.

Pal collaborates with the Translational Genomics Research Institute, Texas A&M University, College Station; and the Children's Cancer Research Center at University of Texas Health Sciences Center at San Antonio.

At Texas Tech, he has worked with Drs. Sunanda Mitra, Brian Nutter and Mary Baker from the Department of Electrical and Computer Engineering, Dr. Bijoy Ghosh from the Department of Mathematics & Statistics and Dr. Michael O'Boyle from the Department of Psychology.

His research has been published in *IEEE Transactions on Signal Processing*, *Signal Processing Magazine*, and *Bioinformatics*.