Research Excellence in Multifunctional Materials

Dr. Thomas Myers
Director, Materials Science and Engineering Program

Dr. Terry Golding
University Chair in Materials Science and Engineering
Director, Center for Research Commercialization

Dr. Ravi Droopad
“Chief Science Officer” Multifunctional Materials

Dr. Bill Covington
Associate VP for Research and Federal Relations
This influx of top-tier talent will greatly add to existing research strengths at Texas State, and help propel the State of Texas to the forefront of the development and commercialization of revolutionary new technologies based on multifunctional materials. The program will help sustain Texas as a leading innovator of new technologies, and will help to enable the promotion of spin-off industries that are seeking solutions to the drain that the State is experiencing in semiconductor manufacturing, while simultaneously drawing on our chemical, pharmaceutical and bio industries. In addition it will help facilitate the education of scientists across all these disciplines, to better prepare the Texas workforce for the future industries that must and will emerge as this technology and industry advance.
Goal: Our program will train graduate scientists and engineers to perform interdisciplinary research on scale-dependent materials and equip them to emerge as effective leaders in the advancement of 21st century global discovery and innovation.

- **Interdisciplinary Ph. D Program Education with relevance**
- **Interdisciplinary Research Efforts Superiority in Multifunctional Materials**
- **Commercialization and Entrepreneurship Tomorrow’s leaders in industry Acquisition of Superior Talent**
Program Support

Academia
- Director Position
- University Chair Position
- 5 Faculty Lines (Plus Start-up)
- Significant Prior Investment

Industry
- Center for Commercialization of Advanced Materials ($1.5M proposed)
- Freescale Research Equipment ($4.5M)
- Motorola Commercialization Equipment ($2M)

Government
- ONR Heterofunctional Materials ($1.8M)
- Emerging Technology Fund ($4M)
- NSF Opportunities
Interdisciplinary MSE PhD program in Scale-dependent Materials

• Abstract submitted for January review
• Chemistry & Biochemistry, Physics, Technology, and the School of Engineering. Linkages to Biology and the Business School
• Faculty: joint appointments to facilitate interdisciplinary nature
• Societal Impact, Technical, Program, and IP Management linking basic discovery and innovation.
• Linkage between commercialization and discovery/innovation

Interdisciplinary Research – the key to the education paradigm of the future
Interdisciplinary MSE PhD program in Scale-dependent Materials

Program tightly coupled with commercialization and entrepreneurial training
  • Interdisciplinary Training / Internships
  • University/Industry Partnerships
  • Technology Transfer/ Business Training/ Assimilation
  • Real life “training”

Technology Transfer
  • Emerging Technology Fund ($4M Funded)
  • Development of a Center for Commercialization
• Multifunctional Materials Research
  Focus on III-V, II-VI, complex oxides, polymers, organic materials
• Molecular Beam Epitaxy Capabilities
  Major equipment donations ($7M)
  Unique in the US!
• Center for NanoPhase Materials/Nanomaterials Application Center
Multifunctional - Material (or device) can be reconfigured to achieve many functions

GaN

Complex Oxides
Or Polymers

Heterostructural Functionality

Gate, $\Delta V_G$

Ferroelectric
Semiconductor

Electronically reconfigurable devices or ultrasensitive multi-component sensors

PhC Biosensor Architecture
Deposition/Analysis Systems

DCA tool: in-situ analysis, MBE
Multi-chamber Research Tool

- One-of-a-kind, custom research tool used for crystal growth/in-situ analysis.
- Examination of crystal growth processes on a layer-by-layer basis.
- 3-inch, single wafer system. All chambers connected by common buffer tube/gate valve system.
Oxide Chamber (x3)

2 e-beams
8 effusion cells ports
RHEED, Xtal Monitor, RGA

Scienta 200mm analyser
- LEED
- XPS
- XPD
- ISS
- Auger
- UPS

In-Situ Analysis

III-V Chamber

SPM

Techniques available
- STM
- SFM or AFM

Elemental sources
Ga, Al, In, Si, Be
As, P crackers
Materials Capabilities

Compound Semiconductors

Si- SiGe

Multifunctional Oxides

InGaAs Channel

(Gd$_x$Ga$_{1-x}$)$_2$O$_3$

GaAs Substrate

GaAs

SrTiO$_3$

Silicon

Materials Science And Engineering

Texas A&M University
San Marcos
The rising STAR of Texas
Solar Flux
$(10^{21}$ photons/sec/m²/µm)$

Lattice parameter
Fig. 1  (a) Band gap energy and corresponding emission wavelength (right hand scale) and (b) below band gap refractive index of various III–V, II–VI, IV–VI, group IV semiconductors and selected fluorides and oxides plotted versus lattice constant.

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The energy gap, and hence absorption properties, of InGaN can be tailored to span any part of the solar spectrum. InGaN is extremely robust and radiation hard.
Texas State served as a model for the implementation of multifunctional materials as the first topic in the new National Science Foundation STTR-only topic/solicitation which will start accepting proposals in February of 2009. This will represent about $11M available for multifunctional materials where university research is stimulated to commercialize its findings. The National Science Foundation SBIR/STTR group is looking for a more active participation of universities in commercializing their research and STTR and multifunctional materials, as a topic, are the right start.

Best regards,
Juan E. Figueroa  Ph.D.
Program Director SBIR
Division of Industrial Innovation
and Partnership
National Science Foundation
Center for Research Commercialization

- Seeded by ETF
- Accelerator/Science Park in San Marcos
- High Tech – Small Business staging
- GreenTech/Texas GreenBelt Alliance
- Industrial Connectivity
Goal: Texas State’s Materials Science and Engineering program will train graduate scientists and engineers to perform interdisciplinary research on scale-dependent materials and equip them to emerge as effective leaders in the advancement of 21st century global discovery and innovation.

- Interdisciplinary Ph. D Program
- Interdisciplinary Research Efforts
- Commercialization and entrepreneurship