006PHY-08

LSU PROPOSAL # 32611

COVER PAGE FOR TRADITIONAL AND UNDERGRADUATE ENHANCEMENT PROPOSALS
BOARD OF REGENTS SUPPORT FUND, FY 2007-08

1. This Proposal Involves: __x__One Institution ____More Than One Institution	2. Enhancement Subprogram: (check one) __x__ **TRADITIONAL** ENH Program (Includes all multidisciplinary proposals) ____ **UNDERGRADUATE** ENH Program

3. This Proposal Is: (check one) __x__ Primarily an Equipment Request ____ Not Primarily an Equipment Request

4. Name(s) of Submitting Institution(s) of Higher Education **Louisiana State University and A & M College**
(Include Branch/Campus/Other Components)

5. Address of Institution of Higher Education (Include Dept/Unit, Street Address/P.O. Box Number, City, State, Zip Code): **Office of Sponsored Programs, Louisiana State University, 330 Thomas Boyd Hall Baton Rouge, LA 70803, USA**

6. Title of Proposed Project: **A QUANTUM-DESIGN PHYSICAL PROPERTY MEASUREMENT SYSTEM (PPMS) FOR NOVEL THERMOELECTRIC MATERIAL STUDIES**

7. First-Year Support Fund Money Requested	8. Second-Year Support Fund Money Requested (if applicable)	9. Proposed Duration (Circle # of Yrs.)
$ 223,090	$ 0	(1) 2

10. Category In Which Proposal Is Being Submitted (check one only)

- __ **BUSINESS**
- __ **MATHEMATICS**
- __ **CHEMISTRY**
- _X_ **PHYSICS/ASTRONOMY**
- __ **EDUCATION**
- __ **Special Multidisciplinary** (See Section III.B.2.c of the RFP.) **NOTE: If you check this category, you must also check at least one other eligible discipline.)**

11. Using the Taxonomy in Appendix A of the RFP, Identify All Specific Subcategories of the General Category That Apply to This Proposal and Provide Taxonomy Numbers:

Subcategory(ies):	Taxonomy Number(s):
Physics and Astronomy	**0807**
Physical Chemistry	**0306**

12. This Proposal Is a: __X__ New Request ____ Request for Continuation of a Previously-Funded Support Fund Project
(check one) Provide previous contract number:

By signing and submitting this proposal, the signators are certifying that: (1) the proposed project has not already been funded/is not currently being funded/has not been promised funding; (2) this proposal has been reviewed and approved by an Institutional Screening Committee; and (3) the institution and the proposed project are in compliance with all applicable Federal and State laws and regulations, including, but not limited to, the required certifications set forth in: (a) Grants for Research and Education in Science and Engineering, NSF Grant Proposals Guide (GPG), NSF 03-2, effective 10/1/02, and (b) 45CFR 620, Subpart F (Requirements for a Drug-Free Workplace).

Name/Title/email (type or print) Institution (if different from Item #5 above)	Dept./Telephone No.	Degree/Year	Signature
PI/PD **Shengmin Guo/ Assistant Professor/ sguo2@lsu.edu**	**ME/(225)-578-7619**	**PhD/1998**	Guo Shengmin
Co-PI/PD **David P. Young / Associate Professor dyoung@phys.lsu.edu**	**Physics/(225)-578-2490**	**PhD/1998**	David Young
Co-PI/PD **Donghui (Catherine) Zhang / Assistant Professor/ dhzhang@lsu.edu**	**Chemistry/(225)-578-4893**	**PhD/2003**	[signature]
Co-PI/PD **D.M.Cao/ Director, Materials Characterization Center/ dcao2@lsu.edu**	**Materials Characterization Center**	**PhD/2004**	Dongmei Cao
Co-PI/PD **M.A. Wahab/Associate Professor/ wahab@me.lsu.edu**	**ME/ (225) 578-5823**	**PhD/1984**	M.A. Wahab

Campus Head or Authorized Institutional Representative		**Dean**		**Authorized Fiscal Agent**	
Name/Title/email: (type or print) James L. Bates, Director, Office of Sponsored Projects		Name/Title/email: (type or print) Zaki Bassiouni, Dean, College of Engineering		Name/Title/email: (type or print) Jerry Baudin, Vice Chancellor for Finance and Administrative Services	
Signature: James L Bates		Signature: [signature]		Signature: James L Bates for	
Date: 10/17/07	Telephone Number: (225) 578-3386	Date: 10/18/07	Telephone Number: 225 578 5703	Date: 11/17/07	Telephone Number: (225) 578-3386

(Form 1-ENH, Rev. 2007)

PROJECT SUMMARY

Name of Institution (Include Branch/Campus and School or Division) **Louisiana State University and A & M College, Baton Rouge**
Address (Include Department) **Dept. Mechanical Engineering, Patrick Taylor Hall, LSU, Baton Rouge, LA, 70803**
Principal Investigator(s) **Shengmin Guo, David P. Young, Donghui (Catherine) Zhang, M. Wahab, D.M. Cao**
Title of Project: **A QUANTUM-DESIGN PHYSICAL PROPERTY MEASUREMENT SYSTEM (PPMS) FOR NOVEL THERMOELECTRIC MATERIAL STUDIES**

Abstract (DO NOT EXCEED 250 WORDS)*

High-efficiency thermoelectric materials are key components for power-generation devices that are designed to convert solar and waste heat, geothermal energy, and other thermal energy into electrical energy. The conversion of solar, waste heat, and other types of thermal energies into electrical energy will play an important role in the current endeavor to develop renewable energy technologies to reduce the US dependence on fossil fuels and to reduce greenhouse gas emissions. For space related applications, high efficient thermoelectric based power generation/recovery system can provide crucial power to spacecrafts, and provide an alternative means for the integrated thermal management system design.

This application requests an enhancement grant to purchase a Quantum Design Physical Property Measurement System (PPMS) for novel high efficiency thermoelectric material studies and for other related research. This Physical Property Measurement System could significantly enhance the research capabilities of LSU College of Engineering, Physics Department, Chemistry Department, and the LSU TIER in the area of novel nano material processing and characterization, which are currently beyond the capability of the existing equipment.

This equipment could promote combined research efforts, including computational materials research on novel thermoelectric materials, and advanced material fabrications and characterizations, to serve the urgent need for new energy technologies and integrated spacecraft thermal management designs. The integrated research strength will enable the PIs to understand the new material properties and to identify optimal processing conditions for maximizing the figure-of-merit and the power factor of new thermoelectric materials.

(Form 2, rev.2007)

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4- Narrative: A *QUANTUM-DESIGN* PHYSICAL PROPERTY MEASUREMENT SYSTEM (PPMS) FOR NOVEL THERMOELECTRIC MATERIAL STUDIES

A. THE CURRENT SITUATION

A.1 Institutional Description

Louisiana State University (LSU) is a Carnegie Research-I university and the flagship institution in Louisiana. LSU is at the forefront of producing cutting-edge science and technology, which is essential to the state's economy. As the flagship institution, the vision for LSU is to be a leading research-based university while motivating undergraduate and graduate students to achieve the highest levels of intellectual and personal development. In implementing this mission, LSU is committed to offer a variety of undergraduate degree programs and extensive graduate research opportunities designed to attract and educate highly qualified students and challenge them for life-long learning.

The Departments of Physics & Astronomy, Chemistry, Mechanical Engineering, and the Center for Materials Characterization share the vision of being recognized as leading programs in the nation. They plan to make fundamental contributions in the area of clean energy and nano-structured novel material studies. Physics & Astronomy, Chemistry, and Mechanical Engineering are among the 11 **Foundations of Excellence** programs at LSU.

A.2 Rationale for Project

The PIs of this proposal are from the departments of Physics & Astronomy, Chemistry, Mechanical Engineering, and Materials Characterization Center. This application requests an enhancement grant to purchase a Quantum Design **Physical Property Measurement System (PPMS)** for novel high efficiency thermoelectric material studies and for other thin film coating related physical property research.

A.2.1 Thermoelectric material introduction

The energy conversion efficiency of a thermoelectric material can be approximately described by the dimensionless thermoelectric figure-of-merit *ZT*:

$$ZT = \frac{S^2 \sigma\, T}{\kappa}, \qquad (1)$$

where, S is the thermoelectric power (or Seebeck coefficient); σ is the electrical conductivity; T is the temperature; and κ is the thermal conductivity. A good thermoelectric material should have a high electrical conductivity to minimize Joule heating, a low thermal conductivity to prevent thermal shorting, and a high Seebeck coefficient to maximize the conversion of heat to electrical power or vice versa. Good thermoelectric properties are often found in electrical conductors and thermal insulators with high Seebeck coefficients [1,2,3]. Most of the research efforts prior to the 1990s were devoted to optimizing the properties of Bi_2Te_3 based alloys in order to improve their thermoelectric capabilities. Recently, it has been suggested, and experimentally verified, that semiconductor quantum wells could improve the materials' figure-of-merit value ZT [4,5]. The improvement arises from the quantum confinement of carriers, which results in the increase of the density of states near Fermi surface. The quantum confinement could enhance the Seebeck coefficient, and at the same time it could reduce the thermal conductivity due to the increased boundary scattering of phonons. **For thermoelectric related research it is crucial to measure the Seebeck coefficient, the electrical conductivity, and the thermal conductivity accurately over a wide range of temperature. The objective of this**

proposal is to acquire a system for such physical property measurements. The following sections describe the immense importance of the physical property measurements in the related research mentioned above.

A.2.2 Thermoelectric based clean energy studies

Thermoelectric materials are commonly used for thermal energy harvesting and conversions. The conversion of solar and waste heat, and other types of thermal energy, into electrical energy plays an important role in the current endeavor to develop renewable energy technologies to reduce the US dependence on fossil fuels and to reduce greenhouse gas emissions. For space related applications, high efficient thermoelectric based power generation/recovery systems can provide crucial power to spacecrafts. It also provides an alternative means for the spacecraft's integrated thermal management system design. PIs from Physics & Astronomy, Chemistry, Mechanical Engineering, and the Materials Characterization Center (MC^2) are collectively involved in this project to acquire a PPMS for the study of physical properties of novel thermoelectric materials and other nano materials. The PIs have established links with many local and out of state industries and have applied for funding to the LA Board of Regents' RCS and ITRS programs, and federal funding bodies (NSF, NASA, DOD, and DOE). Recent acquisition of a Denton Explorer RF/DC Drum Sputter Deposition System, a Sulzer 9MB plasma spray system, together with the recent development of an electrospin test rig give the PIs the unique tools to synthesize novel thermoelectric materials (see section A.3 discussed below). However, the PIs do not currently have the capability to evaluate these novel thermoelectric materials within the College of Engineering (COE). An old designed PPMS in the Co-PI's (**Dr. Young**) lab is heavily used by faculty members from Physics and Chemistry departments and therefore, that piece of equipment is constantly working under full capacity. This has limited the PIs' research activity in the planned clean energy field.

The equipment acquisition will prove very beneficial to the College of Engineering, as well as to the College of Basic Sciences. It is anticipated that the research of at least 10 faculty members in Physics, Chemistry, and Mechanical Engineering will benefit from the acquisition of this equipment. For example, it will benefit Co-PI's (**Dr. Young**) research on the synthesis and characterization of novel electronic and magnetic materials. His research on superconductor film could lead to advances in space travel and transport. The proposed PPMS could greatly enhance Dr. Young's research capability by testing those samples he made under the conditions of cryogenic temperature and strong magnetic field. The goal of the COE PIs (**Drs. Guo & Wahab**) is to develop high efficiency thermoelectric devices to support the new Aerospace Minor Program at LSU. By introducing a new PPMS through a BOR Enhancement Grant, the COE PIs could extend their research field to the novel thermoelectric device based clean energy generation.

For space application, a system capable of measuring physical properties under cryogenic conditions is needed, thus the PIs request a **Physical Property Measurement System (PPMS)** marketed by Quantum Design. Although many other types of physical property measurement systems available on the market, Quantum Design is the only company that manufactures a system that operates at both **cryogenic temperatures and high magnetic fields**. The results of this equipment fund will advance the state-of-the-art of thermoelectric device synthesis and testing. The acquisition of PPMS will represent a major step forward in the enhancement of the research and teaching capabilities. In particular, this equipment will enhance the PIs' current research efforts on computational materials, novel ceramic/thermoelectric materials, advanced nano fabrications, and testing methods, to address how to produce nano-structured novel thermoelectric materials. The proposed equipment and related projects will attract the interest of Louisiana researchers. The academic achievement from the proposed research would promote further interest from the federal government, industrial companies and other research funding organizations to support the PIs' future research. It is anticipated that promising thermoelectric materials will be identified using this new equipment.

A.3 Impact on Existing Resources

This proposal requests the acquisition of a Quantum Design **Physical Property Measurement System (PPMS)** for novel high efficiency thermoelectric material physical property measurements. Such a physical property measurement system is currently not available in the LSU College of Engineering. In the Physics & Astronomy Department, the old PPMS has reached its limit and does not have any room to accommodate new research and educational projects. If this project is funded, it can significantly benefit the PIs in several ways listed below.

- The physical properties of novel thermoelectric materials will be examined using the proposed PPMS. Samples will be characterized for their **specific heat capacity, thermal diffusivity, thermal conductivity, electric conductivity, and Seebeck coefficient** over a wide temperature range. Here is the list of nano-structured thermoelectric material synthesis routes the PIs have acquired recently:

1. **Mechanical Alloying:** The PIs have ceramic processing facilities for mechanical alloying to make thermoelectric materials. In this method, different powders are processed using ball-milling with selected doping atoms and doping concentrations. The samples can then be mechanically pressed, yielding dense, bulk nano composites. Different conditions of the n- and p-type dopings can be used to study the dependence of thermoelectric properties.

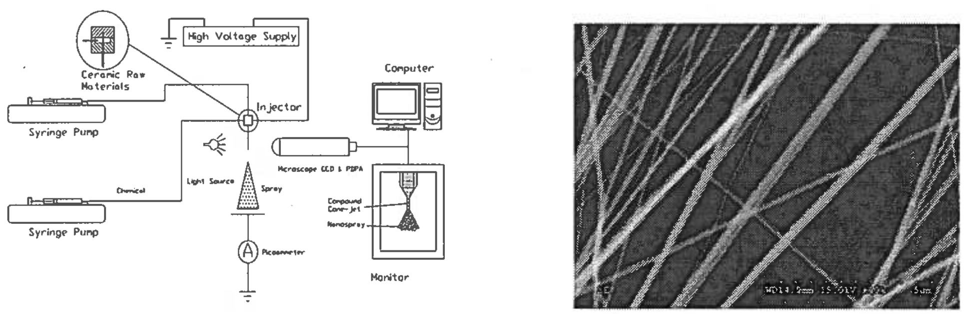

Fig.1. Electrospin rig setup and typical nano fibers fabricated using electrospin

2. **Electrospin,** Fig.1: To reduce the thermal conductivity of the thermoelectric materials, while maintaining a good electrical conductivity, the new electrospin rig in the PI's lab will be used to synthesize thermoelectric nano composite fibers. A nano composite with thermoelectric core will be coated with a thin layer of low thermal conductivity C_{60} fullerenes. The large interfaces between C_{60} and the core thermoelectric material could blockade the phonon diffusion, thus reducing the thermal conductivity of the nano composite fiber. Thermoelectric materials formed in this manner are expected to have the desired excellent electrical conductivity, a high Seebeck coefficient, and a low thermal conductivity. The small size of these nano fibers provides large interfacial surface areas, and the continuous thermoelectric

material core provides a good electrical path. By adjusting the nanofiber diameter, the **interfacial phonon interaction effect** can be studied.

3. **Physical Vapor Deposition:** In this approach, the nano composite thermoelectric material will be made in a vacuum system using co-sputtering/evaporation. In general, a sputter deposition system consists of a vacuum chamber, sputter sources, a substrate holder, and a pumping system. The PI has used such system for thin film gauge fabrications since 1993 [6,7,8]. Using the new sputtering machine, which the PIs acquired in 2007, Bi/Te/Bi_2Te_3 targets will be sputtered, and the C_{60} powder will be thermally evaporated under vacuum from a molybdenum crucible onto substrates for structural and dielectric studies.
4. **Controlled Plasma Spray Coating:** Plasma-Spray will be explored for nano-composite synthesis using the new 9MB system (see section C2). In this approach, unique powder feeding devices will be designed to put different feedings streams, Bi/Te/Bi_2Te_3/C_{60} powders, to different locations of the plasma jet.

- It will enable the PIs to be more competitive in applying for and receiving federal grants, and will help the PIs establish state-of-the-art laboratories necessary for conducting advanced research.
- It will enhance the undergraduate and postgraduate education at LSU. This PPMS facility could be used to analyze samples for Physics labs, Thermofluids labs, Structures and Materials, and other related courses. These courses are the key courses taken by Engineering, Physics, and Chemistry undergraduate students.

B. THE ENHANCEMENT PLAN

B.1 Project Goals and Objectives

The goal of this project is to acquire a Quantum Design **Physical Property Measurement System (PPMS)**. The requested PPMS will complement the existing equipment that the PIs currently have, and will enable the PIs to have a full complement of state-of-the-art equipment that can be used for research involving thermoelectric based clean energies (**ME: Guo & Wahab**), novel electronic and magnetic materials (**Physics: Young**), and synthetic chemistry and biomedical science (**Chemistry: Zhang**). The major milestone of this project is the successful implementation of the PPMS at LSU. **Dr. Cao**, Director of Materials Characterization Center, will introduce this PPMS to a wide user base at LSU, Southern University, and to users from other research institutes and industry in Louisiana. In this proposal, the PIs have a focus on the application of the PPMS to quantify the synthesized nano-sized thermoelectric composites. This equipment will truly provide the PIs with the complete equipment infrastructure that they need to be competitive in thermoelectric based clean energy proposals in the future. The performance measurements due to this equipment grant include the increased high quality publications from the PIs in the fields of novel thermoelectric materials, novel electronic and magnetic materials, and synthetic chemistry. The measurable objective also includes the successful federal grant applications from the PIs and associated Louisiana researchers.

B.2 Work Plan of Proposed Projects

All of the following projects involve the utilization of the proposed Quantum Design **Physical Property Measurement System**, ranging from fundamental/strategic research, to applied research, and to the enhancement of undergraduate and graduate teaching. The immediate research projects that will be facilitated by the provision of the requested equipments are detailed as follows:

B.2.1 New High Efficiency Thermoelectric Materials for Thermal Energy Harvesting

(Drs. Zhao (SU), Guo (LSU), Tang (UNO). NSF pending, $299,400)

Recently, there has been a resurgence of interest in thermoelectric materials due to the demonstration of size-effects to the thermoelectric properties in nano-structured materials. As the system size shrinks to nanometer scale, quantum effects significantly impact the material properties. The underlying mechanism for the enhanced thermoelectric power factor of nano-structured materials is attributed to the energy-filtering effect [9], which strongly lengthens the relaxation time of the high-energy electrons relative to their behavior in the corresponding single crystal material. In order to realize the size-effects, the basic building blocks of the nano-materials should be synthesized with sizes around the electron thermal de Broglie wavelength (typically about 10 nm). In this project, a unique approach will be taken: to develop nano-structured C_{60} fullerene based thermoelectric composite materials. At the moment, there are no detailed reports on C_{60} semiconductors under controlled doping for high efficiency thermoelectric applications. The mean and outer diameters of C_{60} fullerenes are about 0.71 and 1.34 nm, respectively. One of the novel features of C_{60} based semiconductors is their super-low thermal conductivity. The maximum thermal conductivity of C_{60} semiconductors is about three orders of magnitude less than that of graphite/diamond. The unique properties of C_{60} fullerenes provide the real opportunity to develop novel thermoelectric composite materials that have not been known before. In the proposal, samples were planned to be sent to Brookhaven National Laboratory (BNL) for physical property characterization. With a new PPMS system at LSU, a large number of measurements on different samples will be conducted in-house and the PIs will have full control of the data quality.

B.2.2 Advanced High Power Density Fuel Cells

(Dr. Guo (LSU). NSF pending, $399,975)

The overall objective of this Faculty Early Career Development proposal is to establish a highly interdisciplinary, integrated research and educational program in the areas of high power density fuel cells, advanced fuel cell material synthesis, and multi-physics fuel cell simulation. To support the current endeavor of the LSU Mechanical Engineering department (to establish the first Aerospace Minor Program in Louisiana), this CAREER proposal targets high power density fuel cells applicable to the aerospace industry. In this proposal, two promising fuel cell types, the proton exchange membrane fuel cell (PEMFC) and the solid oxide fuel cell (SOFC), will be studied. Because the power density of the current available fuel cells is considerably lower than most heat engines, they are limited in their applicability to aerospace systems, where reducing weight is a primary concern. The technical merit of the planned study is based on a fundamental improvement to the power density curve. This is only achievable through understanding of the fundamentals of fuel cell physics and science, and through the utilization of novel materials and new synthesis methods. Using the new PPMS system, the physical properties of the fuel cell materials will be examined. Coupled with a planned fuel cell simulation tool, the cell performance will be studied based on its physical properties; therefore, the selection of the best fuel cell materials and configurations can be made. This will significantly shorten the development cycle for a new high power density fuel cell. The proposed PPMS will greatly assist the development of new fuel cells and pave the way for the wide application of fuel cells in the aerospace industry.

B.2.3 High Efficiency Nano-Structured Thermoelectric Materials for Integrated Spacecraft Thermal Management

(Drs. Wahab (LSU), Guo (LSU), Zhao (SU). BOR/DEPSCoR pending, $914,723)

The Department of Defense (DoD) and NASA plan to launch and operate a large number of low-mass, low cost space assets in the 21st Century. For the conventional spacecraft, the structural, thermal, and electronic functions are generally designed and fabricated into separate elements. For this approach, the parasitic components may contribute as much as 50% of the mass of spacecraft. Taking advantage of large-scale integrated electronics packaging, lightweight composite structures, and high conductivity materials, Lockheed Martin recently proposed the development of a new manufacturing and integration technology called multifunctional structures (MFS). The overall MFS concept is to embed, for example, electronic assemblies, miniature sensors, and actuators, into load carrying structures along with associated embedded cabling for power and data transmission. The MFS design, inherently, could facilitate the increase in payload-mass fraction by maximizing the ratio of the volume of fundamental electronic parts to the total packaging volume. However, this integration results in higher heat fluxes inside the new load bearing structure. Therefore, thermal management of the new MFS is required for proper operation and acceptable reliability. Novel thermal management is also needed for small spacecrafts, due to the fact that small spacecraft has low thermal capacitance, making them vulnerable to rapid temperature fluctuations; and at the same time, traditional thermal control technologies, such as heaters, thermostats, or heat pipes, do not scale well to meet the constrained power and mass budgets of smaller satellites. Thermoelectric material can operate in cooling/heating mode by passing electricity through it. Compared to standard compressor driven cooling cycles, thermoelectric units do not have any moving mechanical parts. This makes them extremely reliable for space application. For spacecraft thermal management applications, the novel thermoelectric material may join with miniature heat pipes and various types of high-conductivity thermal doublers and straps for enhanced overall performance. In order to achieve an Integrated Spacecraft Thermal Management design, a detailed knowledge on the thermal and electrical properties of both the spacecraft structure materials and the thermoelectric devices must be obtained. Using the new PPMS, the property measurements will provide crucial design data and guidelines for future spacecrafts.

B.2.4 The Development of a Novel Metal Surface Cleaning and Coating System

(Drs. Guo and Wahab (LSU). To be submitted to COE Oil and Gas Initiative, ~ $350,000)

A properly designed and well-maintained pipeline is an extremely efficient means of transmitting energy. The value of the hydrocarbons flowing through pipelines is significant in terms of national economies. For example, a 36 inch diameter oil line can deliver as many as one million barrels of oil per day. At $60 per barrel, such a pipeline can deliver $60 million of oil per day, or $22 billion annually. At the start of the 1990s, there were concerns over the increasing threat of corrosion to pipeline integrity. The corrosion-related cost to the transmission pipeline industry is approximately $5.4 to $8.6 billion annually.

- Corrosion is the major cause of reportable incidents in North America.
- Corrosion is the major cause of pipeline failures in the Gulf of Mexico.

- Corrosion in one pipeline in North America requires over $1 billion in repairs.

Due to corrosion, mechanical integrity of metal structures is usually compromised. Plasma-Spray based coating is the best option to reinstall the mechanical integrity for crucial components. Using the proposed PPMS, the physical properties of the plasma spray coating layers will be studied. This will provide extra information on the coating quality.

<u>B.2.5 Smart Adhesively Bonded High-Performance Joint for Composite Structures</u>

(Drs. Li, Pang, Wahab, Cheng (LSU), Stubblefield (SU). NASA/EPSCoR funded, $1,500,000)

The goal of this three-year NASA/EPSCoR project is to provide NASA aircrafts with durable, reliable, and intelligent adhesively bonded composite joints and enhance the NASA missions, and related research infrastructure in Louisiana. In particular, the research objectives are to: (i) dramatically and self-adaptively reduce peel/shear stress concentrations at the bond line, (ii) self-monitor, self-control, and self-heal the composite joint system in-situ, and (iii) extend the service life of aged/aging aircrafts. The educational objective is to develop a "research-oriented approach" designed to attract and retain a greater number of high caliber students, including minority students, in Science, Technology, Engineering and Mathematics (STEM) disciplines, and to provide a well-trained workforce for NASA and related industries. To support this project, a wide range of mechanical property measurements will be conducted using the existing facility in COE. These tests include static tests, impact tests, fatigue tests, and durability tests. Using the PPMS, extra electrical and thermal properties for the composite samples will be collected. These physical properties could offer extra information for the PIs to understand how the composite structure behaviors under loading and impact forces. These data will guide the PIs to develop novel smart composite materials.

<u>B.2.6 CAREER: The Synthesis and Characterization of Transition Metal and Lanthanide Intermetallic Strongly Correlated Electron Systems</u>

(Dr. Young, NSF funded, $500,000)

When the electrons in a material interact strongly with each other, new phenomena can occur. It is possible to tune the behavior of such materials in ways different from conventional metals and insulators. As an example, by changing the chemical doping of a material, it is possible to make an insulator into an unconventional superconductor. The goal of this Faculty Early Career Development (CAREER) project is to provide insight into the physics of the family of strongly correlated materials known as intermetallics. During this process, technologically useful materials may be discovered. The project includes the synthesis of the materials, and the proposed PPMS will be used to measure the physical properties for these intermetallic materials. The project will involve collaborators at LSU, the National High Magnetic Field Laboratory, and Southern University. Aside from training graduate and undergraduate students in the synthesis of materials, as well as characterization and analysis, the educational component of this CAREER project includes K-12 outreach to minority students.

<u>B.2.7 Block Copolymer Directed Self-Assembly of Carbon Nanotubes for Materials Applications</u>

(Dr. Zhang, to be submitted to BOR-RCS, $123,565)

Because of their unique physical properties, carbon nanotubes (CNTs) have tremendous potential for future technical applications. Well-controlled spatial organization of CNTs is the key for their functionality. The conventional approach is to control the spatial orientation of CNTs in a chemical vapor deposition chamber, at the fabrication stage, which can be difficult for scale-up and control. The goal of this proposal is to investigate the spatial control of CNTs through block copolymer (BC) directed self-assembly method. The proposed strategy entails: (i) the surface functionalization of CNTs with well-defined polymers, and (ii) blending of functionalized CNTs with selected BCs. The high affinity between the functionalized CNT's surface and the complementary blocks of the BCs will result in the selective deposition of CNTs into desired BC domains. Because of the high mechanic resilience of CNTs, it will be possible to deform and confine CNTs into domain sizes less than 300 nm. Relevant material properties of the self-assembled CNT/BC composites will be investigated to assess their potential for certain technical applications that include (i) field emission device, and (ii) conductive and optically transparent coatings. The proposed PPMS will be used to measure the physical properties of the CNTs.

B.3 Evidence of Potential to Achieve Recognized Eminence at the Regional, National, or International Level Commensurate with Degree Offerings and/or Functions

The PIs of this proposal are strong researchers and all have demonstrated the capability for national and international excellence. These investigators are now collaborating with each other in order to bring their expertise to bear on interdisciplinary problems in clean energy, material processing, ceramic thin film fabrication, novel CNTs, and new thermoelectric material development. All these studies require a new state of the art PPMS, which could be regarded as the threshold piece of equipment needed to embark on any of the ideas discussed above. As explained in the earlier sections, the requested system will not only facilitate ongoing research, but also will give the PIs the capability to explore new ideas that they currently cannot pursue (novel thermoelectric materials, nano-structured CNTs, and new engineering coating studies). This will add an extra dimension to the PIs' current research. Publications and presentations of nano-structure thermoelectric materials have been rather limited to date. This equipment will enable the PIs to carry out such advanced research and help the PIs gain national visibility, and the confidence of the federal sponsors.

Section E2, shown later, gives the examples of how this requested PPMS could impact the Louisiana economy. The ability to work on problems having great commercial application potential will allow the PIs to enlist the support of the local industry and engage them in supporting research activities. This, in turn, would give the PIs an advantage in federal competitions where partnering with industry is an advantage (e.g., NSF-GOALI, Center competitions-NSF-ERC, NSF-STC).

Another positive impact of the proposed PPMS equipment is that it serves as a catalyst to promote closer collaborations among the PIs from Physics, Chemistry, and Engineering departments. Industries and federal sponsors tend to view such collaboration more positively since there is a belief that a collaborative environment (between faculty and students) is far better than individual and isolated activity.

B.4 Impact on Curriculum and Instruction

An important goal in higher education is to attract and retain high quality students in science and engineering curricula, and to encourage these students to pursue careers in STEM (science, technology, engineering and math) related fields. In the U.S., the national high technology workforce is rapidly aging, and the number of students entering the workforce as scientists and engineers has been steadily declining over the last several decades. This problem has been identified in numerous studies ranging from assessments of U.S. national security, [10] to reports on the future of the U.S. aerospace industry, [11] and the Aldridge Commission's report on implementing the Vision for Space Exploration [12]. The PIs have a plan to develop a research oriented educational program in Louisiana to address some pressing science and engineering areas in the 21st century – **novel materials, new processing methods, multiphysics simulations, and novel thermoelectric material based clean energy technology**. Science education is the natural byproduct of this proposal, driven by the excitement and visibility of the research to develop novel new thermoelectric materials for future energy generation. Through this project, the PIs will maximize their capabilities to achieve these goals to promote interdisciplinary educational activities involving graduate and undergraduate students. The nature of this equipment will support many interdisciplinary projects which require the students to undergo interdisciplinary training, and to pursue a research program that includes "hands-on" mentoring. Apart from the basic research-skill training, the students involved will be nurtured and trained to become inspirational teachers, exemplary mentors, and effective leaders; attributes necessary for interdisciplinary work they may encounter in their future careers. A nationally-recognized infrastructure is already in place at LSU to support the efforts to broaden the participation of minority students in research and education. The PIs will continue to train undergraduate and graduate students in frontier physics, chemistry, and materials research, and direct interest to contemporary engineering applications. As such, the requested PPMS will measurably contribute to the attainment of the educational objectives of the state of Louisiana.

There are a number of faculty members in LSU College of Engineering and College of Basic Sciences who are interested in clean energy related research. It is anticipated the PIs will also share their experiences gained from this proposed project with LSU postgraduate students. The activities to foster cross-disciplinary interactions amongst several Louisiana Universities are also planned. This will serve the needs of students across campus and across the state of Louisiana. The Clean Power and Energy Research Consortium (CPERC) is a consortium consisting of five schools, Louisiana State University-Baton Rouge (LSU), University of New Orleans (UNO), Southern University-Baton Rouge (SUBR), Nicholls State University-Thibodeaux (Nicholls), and Tulane University-New Orleans (Tulane) to address critical scientific issues in power and energy generation. The primary mission of the Clean Power and Energy Research Consortium is to provide a boost to ongoing research activities in Louisiana, in the area of power generation and emissions control, and to lead the nation in the development of new technologies for the power generation industry with specific emphasis on clean power. Within Louisiana's Clean Power and Energy Research Consortium (CPERC), the total number of graduate students is about 80. Most of them engage in energy related research and it's likely for these students to get a direct benefit from this new equipment. The proposed PPMS will also be available to COE undergraduate students through different labs and undergraduate research projects. The involvement of undergraduate students in research will enhance their knowledge base and expose them to high level of research activities, therefore, encouraging the students to continue their postgraduate education at LSU.

Because thermoelectric based energy generation is inherently multidisciplinary, a critical feature of the technology is the integration of the multidisciplinary activities with multidisciplinary education. The PPMS could greatly enhance some planned new courses in COE, such as Space System, and Clean Energy, by giving students comprehensive knowledge about thermoelectric devices. Introducing the PPMS for thermoelectric based energy education at LSU will address key deficiencies in clean energy education in Louisiana. Moreover, this equipment may help students in obtaining a solid theoretical and practical basis on physics, thermodynamics, heat and mass transfer, electronics, materials, manufacturing methods, and applied control theory.

Specific courses in Mechanical Engineering where this equipment will be used are:

- ME4xxx: A new senior level clean energy course will be developed and offered to the LSU Engineering College undergraduate students. The objective of this course is to give students a thorough knowledge within the field of clean energy design, modeling, control and operation, and manufacturing. The students will quantify novel thermoelectric devices using the proposed PPMS. A Senior Capstone Design project on Clean Energy is already on-going in the Fall of 2007 and the PI is the faculty advisor.
- ME4723 Advanced Materials Analysis: This course requires the students to operate modern analytical instrumentations using photon/electron beams and X-rays; to examine materials macroscopically and microscopically, coupled with testing of mechanical, tribological, and corrosion properties. The PPMS will add a new dimension on thermal and electric property studies.
- Other courses include ME2733 Materials of Engineering, ME3701 Materials of engineering laboratory, and ME3903 Space System Design.

B.5 Impact on Quality of Students

From an educational aspect, this proposed PPMS system could significantly enhance the educational activities by engaging both undergraduate and graduate students in a real thermoelectric device fabrication exercise, which could promote cross-disciplinary collaborations, and increase the number of students attracted to aerospace, clean energy, and power generation fields. This PPMS system could also be used to quantify sample physical properties for Thermo-fluid Labs, Instrumentation Labs, and Structures and Materials Labs. Undergraduate and postgraduate students could use this equipment for class-projects and laboratory experiments, thus contributing immensely towards the engineering and science educational goals for LSU. Using this equipment, new experiments in the areas of heat transfer, electronics, instrumentation, and high efficiency thermoelectric device characterizations could be developed.

Currently, it is almost impossible for LSU faculty to compete with neighboring schools such as Univ. of Texas at Austin, Univ. of Texas A&M, Georgia Tech, and Univ. of Florida because these schools all have state of the art facilities and equipment. LSU has made significant improvements in the past few years. With advanced research capabilities, LSU will be better position to attract high quality graduate students. This facility aids in retaining first class undergraduate students into MSc and PhD programs through the course innovations mentioned in B.4. Unfortunately, many of our high achieving seniors enrolled in ME department's 3+2 program (Accelerated Masters) leave LSU and go for UT Austin or Georgia Tech due to their high quality research infrastructures; therefore to retain our best students within Louisiana we need to invest in infrastructure facilities.

B.6 Impact on Faculty Development

The faculty members in the departments of Physics, Chemistry and Mechanical Engineering will be the first to incorporate the proposed PPMS into their coursework. This equipment will stimulate the interest of students in their classes by addressing the current lack of hands-on experimentation. One example is to use this PPMS in the ME3701 Materials of engineering laboratory, which is part of the curriculum of the ME department. The PPMS could provide new demonstrations on material properties and behaviors. Another example is the ME3903 Space System Design course, taught by the PI recently. To make this course more interesting, new assignments on space material property measurements can be added. The proposed PPMS will also increase the capacity with which the faculty can develop their teaching outside of the classroom through the involvement of undergraduate students in a variety of research projects. For example, the PPMS offers a great opportunity for the PIs to guide undergraduate research projects in the field of thermoelectric devices: ME students can research the effect of thermoelectric device designs to their performance; Physics students can study the effect of magnetic fields to thermoelectric performance; and Chemistry students can study the raw material synthetic methods.

B.7 Performance Measures

1. The success implementation of the PPMS at LSU.
2. The increase of high quality publications in the fields of novel thermoelectric materials, novel electronic and magnetic materials, and synthetic chemistry.
3. The successful federal grant applications from the PIs and associated Louisiana researchers.

C. EQUIPMENT

C.1 Equipment Request

This proposal seeks to acquire a new Quantum Design **PPMS®** system. This system includes base system, the AC Transport Property Measurement System (ACT), Heat Capacity Measurement System (HC), and Thermal Transport System (TTO). This system will provide crucial measurement data to quantify the performance of thermoelectric materials over a wide temperature range, from cryogenic to 400K, with/without a strong magnetic field. Although many other companies also supply physical property measurement systems, Quantum Design is the only company that manufactures an automated physical property measurement system that operates at both **cryogenic temperatures and high magnetic fields**. This temperature range is crucial for **Drs. Guo and Wahab's** (ME) space applications; the high field/temperature range is key for **Dr. Young's** (Physics) electronic and magnetic material research, and **Dr. Zhang's** (Chemistry) multidisciplinary research involving synthetic chemistry, materials science, biomedical science and engineering.

Quantum Design PPMS® uses low-temperature SQUIDs (Superconducting Quantum Interference Devices) and has an open architecture design. For heat capacity measurement, the PPMS® heat capacity puck provides a small micro-calorimeter platform for mounting the samples. The typical sample size is 20 mg. The sample platform is suspended by eight thin wires that serve as the electrical leads for an embedded heater and thermometer under high vacuum. A single heat capacity measurement consists of several distinct stages. First, the sample platform and puck temperatures are stabilized at some initial temperature. Power is then applied to the sample platform heater for a predetermined length of time, causing the sample platform temperature to rise. When the power is terminated, the temperature of the sample platform relaxes toward the puck temperature. The sample platform temperature is monitored throughout both heating and cooling, providing (with the heater power data) the raw data of the heat capacity calculation. The heat capacity resolution is about 10 nJ/K @ 2 K.

The Thermal Transport Module (TTO) of the PPMS® system will measure four thermal transport properties: **Thermal conductivity, Seebeck coefficient, Electrical resistivity and Thermoelectric figure of merit**. The TTO measures thermal conductivity by monitoring the temperature drop along the sample as a known amount of heat passes through the sample. It measures the thermoelectric Seebeck effect as an electrical voltage drop that accompanies a temperature drop. The TTO system can perform thermal conductivity and Seebeck coefficient measurements simultaneously by monitoring both the temperature and voltage drop across a sample as a heat pulse is applied; and the system can also measure electrical resistivity, ρ, by using the standard four-probe method. These measurements will lead to the calculation of thermoelectric figure-of-merit.

The quotation for Quantum Design **PPMS®** is included in Appendix.

C.2 Equipment on Hand for Project

Detailed information on the major available equipment at LSU that is being used in the pursuit of advanced thermoelectric material study is given in <u>Section A.3: Impact on Existing Resources.</u> Several machines will be available to the investigators at the Mechanical Engineering, Physics, and Chemistry departments. In the PI's lab, there is a Denton Explorer RF/DC Drum Sputter Deposition System, a 9MB Plasma Spray System, and in the PI's fuel cell lab, he has high temperature furnaces, an electrospin rig, and other ceramic processing equipment. In Dr. Cao's Materials Characterization Center, there is a JEOL JEM 2010 200 kV transmission electron microscope (TEM), a Kratos Axis 165 scanning XPS/Auger spectrometer with Ar+ sputter depth profiling (XPS/SAES), a Hitachi S-3600N variable pressure scanning electron microscope (SEM), a Rigaku Miniflex X-ray diffractometer (XRD), a Wyko NT1000 3-D optical profiling system, a Perkin-Elmer DSC7 differential scanning calorimeter (DSC), and a Gatan 656 Dimpler and Gatan 691 Precision Ion Polishing System. Dr.Wahab's Composite Lab has the necessary equipment to measure mechanical properties.

C.3 Equipment Housing and Maintenance

This system will be installed in LSU College of Engineering. The Department of Mechanical Engineering will provide one month salary to reduce the teaching load of Dr. Guo (PI) (see supporting letter from Prof. Sinclair in the Appendix), so Dr. Guo can receive training on this state-of-the-art system during the installation stage. Video recordings will be available for viewing by parties who will be using the machine at a later date. The new user will be accompanied by one of the investigators at the beginning of use. Dr. Guo will provide technical support and training, including safety, to other users. LSU will provide $15,000 to upgrade the PI's lab to accommodate this system. LSU will also provide $25,000 for supplies, mainly for liquid helium and liquid nitrogen during the 1st year. This equipment is covered by a standard warranty against defects in materials or workmanship for a period of one year by the vendor. Beyond this time, proper and routine maintenance will be provided by the LSU Mechanical

Engineering department, project PIs, and the department's technical staff. No additional support personnel will be required.

Maintenance and Repair:

LSU's Office of Research and Economic Development has established an Equipment Repair Fund. This will be the first place for the PIs to seek help when repair becomes necessary. For routine maintenance, the cost is only $1K/year, which can be easily covered by the PIs' Overhead Return account. The PIs have committed to use these overhead accounts to maintain the PPMS. The Department of Mechanical Engineering has expert technicians who have the training and expertise to repair scientific equipment. Graduate students will also be trained to use the equipment properly, which will eliminate unjustified problems due to normal operations.

D FACULTY AND STAFF EXPERTISE

D.1. Expertise of PI, Co-PIs & Other Investigators:

Dr. Shengmin Guo (PI) has been very active, and has a strong track record, in the field of turbomachinery, fuel cells, nanofiber synthesis, and clean energy research. He received his PhD in 1998 at Oxford University. While a Departmental Faculty member in Engineering Science at Oxford University, UK, he was responsible for the operation of the largest gas turbine nozzle guide vane test rig in the world. After he joined LSU in 2004 from England, he setup the first Fuel Cell lab at LSU. At LSU, he was recently responsible for improving the Turbomachinery and Aerodynamics courses, and a large number of Senior-design-projects (~ 5 per year). With NASA/LaSPACE support, Dr. Guo has started preliminary work for nano material synthesis, which can be used as a novel feeding for the thermoelectric devices [13,14]. In Dr. Guo's lab, there is essential equipment for nano-structured thermoelectric material synthesis, see Section C2.

Dr. David Young (Co-PI), Associate Professor, Department of Physics at LSU. Dr. Young obtained his PhD in Physics from Florida University, he then went to Princeton University and worked in the areas of Novel materials. He has published extensively in the areas of materials characterizations. The PPMS will be immensely valuable for his current research initiatives at LSU. Dr. Young's group has extensive knowledge in low-temperature physics techniques and the measurement of electronic transport and magnetic properties. Having this new PPMS on campus will allow his group the opportunity to further their research experience to thermoelectric property studies.

Dr. M A Wahab (Co-PI) received his PhD degree (1984) in Mechanical Engineering from the University of Alberta, Canada. After his graduation from the University of Alberta, he subsequently moved to Australia where he worked in four universities for several years before joining LSU in 2002. Dr. Wahab has 30 years of teaching and research experience in the areas of fatigue and fracture mechanics, materials welding & joining, composite material, structure integrity, and mechanical design. Dr. Wahab will utilize his facility to study the mechanical aspects of thermoelectric materials.

Dr. D.M. Cao (Co-PI) is the manager of the LSU Materials Characterization Center (MC^2). MC^2 is a university-wide user facility for material micro-structural and chemical characterization. Dr. Cao's research mainly involves material characterization with SEM, TEM, XPS, XRD etc. techniques. Dr. Cao received her Ph.D in the department of mechanical engineering at Louisiana State University in 2004. She has worked on a number of research topics, ranging from microstructural characterization, mechanical and tribological properties of metal-containing hydrocarbon (Me-C:H) nanocomposite coatings, to surface engineering of microscale metallic mold inserts, and molding replication of metal-based high-aspect-ratio microscale structures (HARMS) with surface-engineered metallic mold inserts.

Dr. Donghui Zhang (Co-PI), Assistant Professor, Department of Chemistry at LSU. Dr. Zhang obtained her Ph.D. in Chemistry from Dartmouth College and then went on to the University of Minnesota where she worked in the area of biorenewable polymer synthesis and characterization. She then worked as a research assistant professor at New Mexico State University. Her work during this time focused on fabrication of carbon nanotube polymer composites, and spectroscopic and electrical characterizations of the composite materials. Dr. Zhang's current research interests focus on the design, synthesis, and physical property characterization of functional materials (molecular or polymeric) for different materials applications.

The PIs will maintain the collaboration with **Dr. Qiang Li**, a Physicist in the Condensed Matter Physics and Materials Science Department at the **Brookhaven National Laboratory** (BNL). Currently, Dr.Li is the Principal Investigator of the superconducting and thermoelectric materials program at BNL, and leads the broader effort in the energy application of thermoelectric materials at BNL. His extensive involvement in the thermoelectric community provides a means for the PIs to respond rapidly and aggressively to new developments, as well as the ability to reconfigure the research thrust to respond to new challenges if they occur.

D.2. Responsibilities of the PI, Co-PIs and Investigators:

The PI (Dr. Guo) will be involved in organizing installations of the PPMS and will be responsible for overall maintenance of the testing system. He will also be involved in training both undergraduate and graduate students in using the testing facility. The investigators from Physics, Chemistry, and Mechanical Engineering at LSU will be involved in designing various Laboratory experiments relevant to their undergraduate teaching courses and will also be involved in their specific research projects described in **Section B** in this Grant application. Collectively, the PI and Co-PIs will work together or individually towards securing Federal and Industrial funds to expand their research areas and also increase this basic testing infrastructure into larger testing facilities.

E ECONOMIC DEVELOPMENT AND IMPACT

E.1 Relationships with Industrial/Institutional Sponsors

The proposed equipment can be used for research directly in line with the mission of the LSU- College of Engineering, College of Basic Sciences, and Louisiana-Clean Power & Energy Research Consortium, with which the PIs are affiliated. As such, dissemination and technology transfer to industry will be mainly facilitated by LSU and CPERC's activities and industrial partners.

E.2 Promotion of Economic Development

The economic development of Louisiana can stem from a variety of direct and indirect activities. The establishment of a top-class laboratory with state-of-the-art equipment and facilities will generate local industry participation. This is likely to lead to three tangible benefits: (1) the resolution of problems of local industries, making them more competitive in the national and international market; (2) the promotion of new clean energy industry at Louisiana, and (3) the training of students on problems of industrial relevance. These students can then be directly employed by local industries.

The proposed equipment (PPMS) will enable the PIs to understand the material physical properties, and identify optimal processing conditions to maximize the figure-of-merit and the power-factor of the new thermoelectric materials. The successful application of this equipment could guide the advanced studies on novel thermoelectric materials. Large-scale adoption of thermoelectric based power generation technique will reduce the national fuel consumption and greenhouse emissions. This project could greatly assist the future development of thermoelectric devices, develop local based clean energy manufacturing capability, and therefore will have broad economic impact. There is a potential to generate several technical patents through studies using the PPMS. The proposed research efforts on novel thermoelectric materials could make a significant contribution to the knowledge about clean energy generation and could easily spawn spin-off companies to support the development of Louisiana based clean energy industry. By fostering a strong clean energy research basis at LSU, Louisiana can move into the lead among the states and nations in directing this new technology development.

F ADDITIONAL FUNDING SOURCES

This proposal is directly in line with one of the thrust areas of the COE – Clean Energy development. This thrust area also aligns with the future energy plans of Louisiana. If widely used, thermoelectric devices could provide both public and private benefits due to their ability to provide high-quality, and clean energy. The **Mechanical Engineering department**, the **College of Engineering**, and the **Office of Vice-Chancellor for Research and Economic Development** will jointly provide a $40,000 matching fund to support this application. The Department of Mechanical Engineering will also provide one month salary to reduce the teaching load of Dr. Guo so he will receive training on this state-of-the-art system, and provide support to other users. The overhead for this Institutional Match is 47%. Total support from LSU is $74,686, see the supporting letter from Prof. Sinclair in Appendix 9-1.

References:

[1] D.M. Rowe and C.M. Bhandari, *Modern Thermoelectrics*, (Holt, Renehart and Winston, Ltd, Eastbourne, 1983).

[2] H. J. Goldsmid, *Electronic Refrigeration*, (Pion Limited, London, 1986).

[3] D. M. Rowe, *Thermoelectrics Hankbook – Macro to Nano*, (CRC-Taylor & Francis, Boca Raton, FL, 2006).

[4] L. D. Hicks, M. S. Dresselhaus, Phys. Rev. B, **47**, 12727 (1993).

[5] L. D. Hicks, Harman, T. C., X. Sun, M. S. Dresselhaus, Phys. Rev. B, **53**, 10493 (1996).

[6] Guo S.M., Lai C.C., Jones T.V., Oldfield M.L.G., Lock G.D., Rawlinson A.J., 1998, International Journal of Heat and Fluid Flow Vol 19, No. 6 pp594-600

[7] Piccini E., Guo S.M., Jones T.V., 2000, Journal of Measurement Science and Technology, Vol 11 p342-349

[8] Guo S.M., Lai C.C., Jones T.V., Oldfield M.L.G., Lock G.D., Rawlinson A.J., 2000, Transactions of the ASME: Journal of Turbomachinery, Vol. 122, No. 4, pp709-716

[9] D. Vashaee and A. Shakouri, Phys. Rev. Lett. **92**, 106103, (2004).

[10] G. Hart, W. B. Rudman, A. Armstrong, *et al.*, *The Phase III Report of the U.S. Commission on National Security/21st Century*, Washington, D.C., 2001, http://govinfo.library.unt.edu/nssg/PhaseIIIFR.pdf

[11] R. S. Walker, F. W. Peters, B. Aldrin, *et al.*, *Final Report of the Commission on the Future of the United States Aerospace Industry*, (2002), http://www.spacefoundation.org/policy/docs/media_bkgd.pdf

[12] B. C. Jr. Aldridge, C. S. Fiorina, M. P. Jackson, L. A. Leshin, L. L. Lyles, P. O. Spudis, N. D. Tyson, R. S. Walker, and M. T. Zuber, ISBN 0-16-073075-9, Superintendent of Documents, U.S. Government Printing Office, Mail Stop SSOP, Washington, DC 20402-001, 2004

[13] R. Bajon, S. Balaji, S.M. Guo, 2007, ASME FuelCell2007-25200

[14] R. Bajon, S. Balaji, S.M. Guo, 2007, ASME FuelCell2007-25201

5. PREVIOUS BoR SUPPORT FUND AWARDS

Dr.Shengmin Guo, the PI of this grant application had no previous award from the Board of Regents Support funds. He has three on-going awards as PI and two on-going awards as Co-PI from the Board of Regents Support funds.

PI: Shengmin Guo
Project No.1: A Plasma Spray System for Solid Oxide Fuel Cell Fabrication and Plasma Coating
Source of Support: BOR-Enhancement: LEQSF(2006-2007)-ENH-TR-13
Award Amount (or Annual Rate): $142,670
Period Covered: 5/2006-6/2008

PI: Shengmin Guo
Project No.2: Electro Spray Based Micro Reactor
Source of Support: Louisiana Board of Regents RCS
Award Amount (or Annual Rate): $129,955
Period Covered: 6/2007 - 6/2010

PI: Shengmin Guo
Project No.3: Production of Ceramic Materials from Agricultural Waste
Source of Support: Louisiana Board of Regents ITRS
Award Amount (or Annual Rate): $156,864
Period Covered:6/2007 - 6/2010

These on-going projects give Dr.Guo the unique capability to synthesize nano-structured materials, including novel thermoelectric materials, and lead directly to this equipment proposal. As discussed above in Project Narrative, the current proposal will be complementary to our experimental research investigation and many physical properties could be evaluated and modeling work will be carried out. This Physical Property Measurement System (PPMS) will be absolutely valuable to the PIs.

PI: Sumanta Acharya, Guo (Co-PI)
Proposal Title: A High Speed Infra-Red Thermal Imaging and Flow Visualization System
Source of Support: LEQSF(2006-2007)-ENH-TR-08
Award Amount (or Annual Rate): $197,000
Period Covered: 5/2006-6/2008

PI: Dimitris Nikitopoulos, Guo (Co-PI)
Proposal Title: A Real-Time, Stereoscopic Imaging System for Multi-Scale Applications
Source of Support: LEQSF(2006-2007)-ENH-TR-21
Award Amount (or Annual Rate): $177,000
Period Covered: 5/2006-6/2008

Dr. David P. Young, the Co-PI of this grant application had one previous award and one on-going award from the Board of Regents Support funds.

Title: *New materials search for novel thermoelectrics for small-scale cooling and power generation*
Grant Number: LEQSF (2001-04)-RD-A-11 (PI: D.P. Young)
Program: Research Competitiveness Subprogram
Dates: 06/2001 – 12/2004
Amount: **$123,000**

The goals of the thermoelectric project were the following: Year 1: Synthesize and screen many new materials for potential thermoelectrics and identify several good materials for optimization. Year 2: Use feedback from physical property characterization to determine the optimal processing conditions for the materials outlined in year 1 and continue to search for other new materials. Year 3: Fabricate a prototype device from the best material and test its cooling capabilities. The ultimate goal of the thermoelectric project would be a transfer of this technology to industrial users, with an emphasis on the electronic cooling of microprocessors.

Near the end of the first year, we had discovered one material, Ag_8GeTe_6 (Ag816), which displayed some very unique electronic properties. The material is a mixed conductor, and thus uses both electrons and positive silver ions to conduct electricity. The thermal conductivity is extremely low, comparable to cardboard, and is much lower than the present day best thermoelectrics. Much of our effort during the past year has been focused on optimizing the electronic properties of Ag816. All of the Ag816 samples were synthesized with the RF generator that was purchased with funds from this proposal. The majority of the past year was spent creating a device out of the Ag816 material. It consists of a solid bar-shaped polycrystalline sample approximately 6 mm in length with a 4-mm^2 cross-sectional area. The bar has temperature sensors and thermocouples mounted along its length, in addition to electrical leads for supplying current and measuring voltages. The thermal and electronic characteristics have been studied near room temperature, and we intend to fully characterize the temperature dependence of the device's performance during the 6-month extension of this research project. Other materials were also synthesized and measured during this funding period, including $MgCNi_3$ which is a superconducting material at low temperature, and has since been fabricated into very long and thin superconducting wire. This wire may have many applications in magnetic field creation, an area of research important to the Army, NASA, DoD, etc. Our creation of this wire has lead to funding from the Army. To date, this work has resulted in roughly 30 publications with more pending.

Subsequent to this work, the lead PI has been awarded a CAREER grant by the National Science Foundation. The level of funding is at half a million dollars for 5 years. Success of this research proposal was strongly rooted in the significant publication record produced during the BoR funding period.

Dr. Young acquired extensive experiences on quantify thermoelectric materials using a similar Quantum-Design equipment. This will benefit this equipment proposal in terms of equipment setup, training, and guide future research direction in thermoelectric device field.

<u>Dr. M. A. Wahab</u>, the Co-PI of this grant application had two previous award and one on-going award from the Board of Regents Support funds. A brief summary is provided below as to what have been achieved through these BoR support funds.

Project #1:

Project Director's name, amount of award, and period of support: Dr. M. A. Wahab (PI), $65,200, LEQSF Contract #: LEQSF(2005-06)-ENH-TR-25, (LSU Acct. No.: 127-40-4198), 06/01/05 through 06/30/06

Title of the project: "Equipment Enhancement Grant-Research Enhancement through the Acquisition of Universal Materials Testing Systems"

Summary of the results of the completed work:

The goals of the project are the acquisition of a Universal Material Testing System (UMTS), which is capable of performing basic fatigue (low & high cycles, and multi-axial fatigue tests), fracture mechanics evaluation, and strength evaluation tests of metals, non-metals, structures, and composites. This has generated a fundamental much-needed laboratory teaching facilities and has enhanced the basic research capabilities at Louisiana State University (LSU). The facility has been used in performing both basic and advanced tests to understand the materials properties evaluation. The PIs of this project have received a total of 10-new research/educational grants after securing this grant on 06/01/05, i.e., the starting date of this project. These include a much recognized research grant of $1,500,000 funded by the U.S. Department of Energy. This Board of Regents equipment grant has not only provided a contribution in enhancing the infrastructure of Mechanical Engineering Departments at LSU, but also the infrastructure between LSU and SU. Currently, at least 15 graduate students are actively using this testing facility to generate valuable research data towards completion of their research degrees. Three PhD students and six Masters Students have already used this facility and degrees have been granted to them recently.

Dr.Wahab will use his equipment, including the UMTS to provide the mechanical property measurements for the proposed thermoelectric device studies.

Project #2:

1. Project Director's name, amount of award, and period of support: M.A. Wahab, $33,758, 06/01/06 – 06/30/07
2. Title of Proposed Project: "Fatigue and Micro Characteristics Analysis of Friction- Stir-Welded (FSW) Joints of Al-2195 Alloys," (NASA/EPSCoR-BoR," Contract No.: NASA/LEQSF (2006)-DART-27, LSU Account Number: 127-40-4186).

Summary of the results of the completed work

This study presents the fatigue testing results of the friction-stir-welded (FSW) butt-joints for Al-Li alloy (Al-2195) under varying testing conditions of constant amplitude, variable amplitude, under humid conditions, with Corrosion-Prevention-Compound (CPC), and without CPC. The welded joints are tested according to Testing Standard- ASTM-E647. In general it is found that CPC, water-vapor and overloading improve fatigue life. After performing fatigue testing the samples are cut from the near-failure surfaces of different mode areas (tensile, shear and brittle modes of failure) and are examined using the Scanning Electron Microscope (SEM). The different fatigue failure characteristics observed in different failure areas are discussed in the report. The cracks were generated in the weld nugget region, it has been observed that the fatigue crack proceeds gradually with the crack-closure phenomenon predominating the failure mechanism, the crack morphology and angle of crack propagation depends on the quality of the weld in the nugget region. The specimen, where micro-voids and defects are observed the material bonding is discontinuous, the propagation of the crack proceeds through the weakest region in the weld through sudden changes in angle and eventually shear failure occurs. Though the crack propagation is gradual, the life is found to be significantly lesser in the specimen with defects in the weld region than the specimen without any defects in the weld-nugget region. The microstructure of the failure surfaces in all these cases are studied, it is found that the anisotropic nature of the material and the dynamic recrystallization of the weld-nugget prompt the redistribution of the precipitates and realignment of grain-boundaries. The variation of material properties in this weld-nugget region and the weak-zones in the weld contribute to the decrease in fatigue life. The use of CPC has significantly improved fatigue life.

An explanation of the manner in which the current proposal is related to the previous award:

The earlier grant was used heavily for fatigue data generation and the current equipment application will generate thermo-mechanical data and will create wider application to our research. The specimens will be characterized for their specific heat capacity, thermal diffusivity, thermal conductivity, electric conductivity, and Seebeck coefficient over a wide temperature range and new type of thermal fatigue analysis could also be started with nano-structures.

Ongoing Project:

Project Director's name, amount of award, and period of support: Dr. M. A. Wahab, $155,000, 06/01/04 - 06/30/08. The project is still on-going and will be completed on 06/30/08.

Title of the project: Development of Unconventional Composite Pipes, Ducts, Joints, and Fittings for Low-to-Moderate Pressure Marine Applications, LEQSF Contract #: LEQSF (2004-07)-RD-B-07

BOARD OF REGENTS SUPPORT FUND
TRADITIONAL AND UNDERGRADUATE ENHANCEMENT, FY 2007-08

Budget and Budget Justification Pages
Project Year (1) 2 Composite

Directions: Each line item under the columns "Support Fund Money Requested," "Institutional Match," and "Private Sector/Other Match" must be itemized, fully explained, and justified on **a separate budget justification page(s)**. Attach additional justification pages as needed.

Title of Proposal: A QUANTUM-DESIGN PHYSICAL PROPERTY MEASUREMENT SYSTEM (PPM FOR NOVEL THERMOELECTRIC MATERIAL STUDIES

Project Director(s): Dr. Shengmin Guo

Institution(s) of Higher Education: Louisiana State University and Agricultural and Mechanical College

PROPOSED BUDGET:

	Support Fund Money Requested[a]	Institutional Match[1b]	Private/Other Match[2]
A. Equipment[3]	$221,090		
B. Software			
C. Supplies	$2,000	$25,000	
D. Shipping/handling			
E. Installation			
F. Personnel training		$10,807	
G. Other			
1. Lab update		$15,000	
2.			
3.			
4.			
5. (etc.)			
H.Indirect costs	Not Allowed	$23,879 c	$0 c
I. Maintenance	Strongly discouraged		
J. Total costs (A-I)	$223,090	$74,686	$0

[1] Stipulate whether in-cash or in-kind. The Board strongly encourages the sharing of costs for proposed projects. Applicants and institutional officials should note, however, that the employing institution will be required to honor the commitments made in the original proposal before any awards are made. Discounts for equipment purchases are not allowable as institutional match.

[2] The budget page(s) must reflect and the budget justification pages must explain any external funds that are claimed in the proposal. External funds and their expenditure must be accounted for in the same manner as Support Fund money and institutional match.

[3] Equipment.If applicable, itemize and describe briefly the proposed equipment and its intended use in the project. Include the name, model number, and manufacturer(s).

[a] Support Fund monies will not supplant state funds, and full time employees will not, under any circumstances, receive funds in excess of 100% of their regular salaries

[b] This match (In-cash) will be funded through Departmental or College operating budgets

[c] Indirect costs (F&A) at a rate of 47% of Modified Total Direct Costs (MTDC) has been applied based on current negotiated rate.

Budget Justification: Support Fund Money Requested

A: Equipment: $221,090

QTY	MODEL	DESCRIPTION	PRICE
1	PPMS7	PPMS Base System with a 7 Tesla Long. Magnet & Power Supply	$126,550
1	P400	Resistivity Option	N/C
1	P600A	AC Transport Property Measurement System (ACT)	$13,970
1	P650	Heat Capacity Measurement System (HC) (Includes P640)	$54,020
1	P670	Thermal Transport System (TTO) (Requires P400, P600, and P640)	$16,610
1	P925A	High Capacity Nitrogen Jacketed Dewar Upgrade	$6,940
1		Shipping/handling	$3,000

C: Supplies: $2,000
This is for the supply of consumables, such as liquid helium, liquid nitrogen, and special samples, during the start-up of the system.

J: Total Cost: $223,090

Budget Justification: Institutional Match

C: Supplies: $25,000

This equipment needs liquid helium and liquid nitrogen. The typical helium consumption rate is about 100L/week. At $7/L, helium costs $700/week. The liquid nitrogen costs about $100/week. LSU will provide $25,000 for the purchase of these special gases.

G: Other, Lab update: $15,000

This is for lab upgrade to accommodate this PPMS system, which includes extra ventilation, safety devices, furniture and lighting for operators.

F. Personnel training: $10,807

The Department of Mechanical Engineering will provide one-month salary, $8065, with fringe benefit, 34%, to reduce the teaching load of Dr. Guo, so he could work on this state-of-the-art system. Dr.Guo is on 9 months appointment with LSU and has an annual salary of $72,585.

H. Indirect costs: 47%, $23,879

J. Total costs (A-I): $74,686

BIOGRAPHICAL SKETCH			
Provide the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.			
Name **Shengmin Guo**		Position Title **Assistant Professor**	
EDUCATION (Begin with baccalaureate or other initial professional education and include postdoctoral training.			
INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Dept. of Engineering Mechanics, Tsinghua University, China	B.Eng.	1991	Engineering Mechanics
Dept. of Engineering Mechanics, Tsinghua University, China	M.Eng.	1993	Fluid Mechanics
University of Oxford, England	D.Phil	1998	Engineering Science

RESEARCH AND PROFESSIONAL EXPERIENCE: Starting with present position, list, in reverse chronological order, previous relevant employment, experience, and honors. Key personnel includes the principal investigator and any other individuals who participate in the development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in reverse chronological order, the titles, all authors, and complete references to pertinent publications during the past five years and to representative earlier publications pertinent to this application. DO NOT EXCEED TWO PAGES.

8/04 – present:	Assistant Professor, Louisiana State University
1/04 – 8/04:	Visiting Assistant Professor, Louisiana State University
4/02 – 8/04:	Lecturer in Mechanical, Aerospace and Manufacturing Engineering, University of Manchester Institute of Science and Technology (UMIST), England
11/98 – 3/02:	Departmental Lecturer in Engineering Science, Department of Engineering Science, University of Oxford, England
10/99 – 3/02:	Somerville College (Oxford, England) Engineering Tutor
10/98 – 10/99:	Keble College (Oxford, England) Engineering Tutor
10/96 – 10/98:	Post-Doctoral Research Assistant, Rolls-Royce UTC for Heat Transfer and Aerodynamics, University of Oxford, England

Awards and Honors

2001	The American Society of Mechanical Engineers (ASME) Best Heat Transfer Paper Award
2000	EUROTHERM Young Scientist Prize And Awards Honourable Mention

Selected Publications

Five Sample Publications related to the present proposal

5 R. Bajon, S. Balaji, S.M. Guo, 2007, Electrospinning Nafion Nano Fiber For PEMFC Application, ASME Fuel Cell 2007-25200

4 R. Bajon, S. Balaji, S.M. Guo, 2007, YSZ Nano Fiber Synthesis Using Electrospinning Method, ASME Fuel Cell 2007-25201

3 Guo S.M., Silva M.B., Mensah P. F., Uppu N., 2007, The Study of Thermal Properties and Micro Structures of YSZ, ASME-GT2007-28147

2 Guo, Y.D., Guo, S.M., and Turan, A., 2005, The Simulation of Solid Oxide Fuel-Cell Membrane-Electrode Assembly, The Electrochemical Society PV 2005-07, ISBN 1-56677-465-9, Solid Oxide Fuel Cells (SOFC IX), pp758-770.

1 Washak, H., Guo, S.M., and Turan, A., 2005, Gas Transport In Porous Electrodes Of Solid Oxide Fuel Cells, The Electrochemical Society PV 2005-07, ISBN 1-56677-465-9, Solid Oxide Fuel Cells (SOFC IX), pp729-737

Five Additional Publications

5 Guo, S.M., 2005, The Simulation of a PEMFC with an Interdigitated Flow Field Design, Lecture Notes in Computer Science, Springer-Verlag GmbH, ISSN: 0302-9743, Vol. 3516, PP 104-111

4 Pomfret, J. R., Guo, S.M., Oldfield, M.L.G. and Rawlinson A.J, 2002, A High-Speed Concentration Probe for the Study of Gas Turbine Vane Film Cooling, Journal of Measurement Science and Technology, Vol 13 pp 1966-1974

3 Sargison J.E., Guo S.M., Oldfield M.L.G., Lock, G.D., Rawlinson A.J, 2002, A Converging Slot-Hole Film-Cooling Geometry. Part 2 Transonic Nozzle Guide Vane Heat Transfer and Loss, Transactions of the ASME: Journal of Turbomachinery, Vol. 124, pp 461-471, **ASME 2001 Best Paper Award**

2 Guo S.M., Lai C.C., Jones T.V., Oldfield M.L.G., Lock G.D., Rawlinson A.J., 2000, Influence of Surface Roughness on Heat Transfer and Effectiveness for a Fully Film Cooled Nozzle Guide Vane Measured by Wide Band Liquid Crystals and Direct Heat Flux Gauges, Transactions of the ASME: Journal of Turbomachinery, Vol. 122, No. 4, pp709-716

1 Guo, S.M., Jones, T.V., Lock, G.D., and Dancer, S.N., 1998, Computational Prediction of Heat Transfer to Gas Turbine Nozzle Guide Vanes, Transactions of the ASME: Journal of Turbomachinery, Vol. 120, No. 2, pp343-350.

Synergistic Activities

5. Developed Fuel Cell Lab with advanced ceramic and nano material processing capabilities at LSU
4. Peer Reviewer for ASME International Gas Turbine Institute; ASME Journal of Heat Transfer; The National Science Foundation (NSF); USDA; Institute of Physics: Journal of Measurement Science and Technology; International Journal of Mechanical Engineering Education; International Journal of Heat and Fluid Flow; Journal of Power and Energy; Proceedings of the Institution of Mechanical Engineers Part A; Thomson Brooks/Cole; European Gas Turbine Conference; John Wiley & Sons; McGraw-Hill; Member of mechanical engineering committee, National Council of Examiners for Engineering and Surveying (NCEES)
3. Developing Aerospace minor program at LSU since 2006
2. Faculty advisor of NASA/LaSPACE funded HASP project 2005-2007
1. Faculty advisor of LSU AIAA

Collaborators within Last 48 Months

T.V. Jones, M.L.G. Oldfield, J.R. Pomfret, A.J. Rawlinson , J.E. Sargison, G.D. Lock, E. Piccini, C.C. Lai, A.K. Owen, S. Hogg, S. Vasco, A.E. Forest, A.J. White, P. Price, M. Hirschmann, V. Mexas, S. V. Ekkad, D.M. Chao, S.Acharya, D. Nikitopoulos, M.Wahab

Graduate and Post-Doctoral Advisors

Prof. T.V. Jones, University of Oxford, United Kingdom
Prof. B.S. Xi, Tsinghua University, China

Thesis Advisor and Postgraduate-Scholar Sponsor

MD Zoolfakar (Malaysia), MA Yusmady(Malaysia), V. Mexas (Greece), K. Mussa(UMIST), SY Cheung (UMIST), H Washak(UMIST), B Yang(Beijing China), YD Guo (Beijing, China), NI ElHabeshi (UMIST), S. Vasco (Oxford University), J.R. Pomfret (Oxford, UK), J.E. Sargison

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and consultants and collaborators. Begin with the Principal investigator/program director. Photocopy this page for each person.

NAME **David P. Young**	POSITION TITLE **Associate Professor**

EDUCATION (Begin with baccalaureate or other initial professional education and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Truman State University	**BS**	**1993**	**Physics**
Florida State University	**MS**	**1995**	**Condensed Matter Physics**
Florida State University	**Ph.D.**	**1998**	**Condensed Matter Physics**
Princeton University	**postdoc**	**-**	**Novel Materials**

RESEARCH AND PROFESSIONAL EXPERIENCE: Starting with present position, list, in reverse chronological order, previous relevant employment, experience, and honors. Key personnel includes the principal investigator and any other individuals who participate in the development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in reverse chronological order, the titles, all authors, and complete references to pertinent publications during the past five years and to representative earlier publications pertinent to this application.
DO NOT EXCEED TWO PAGES.

August 2005 – Present	**Associate Professor of Physics**	**Department of Physics and Astronomy, Louisiana State University**
August 2000 – August 2005	**Assistant Professor of Physics**	**Department of Physics and Astronomy, Louisiana State University**
September 1998 – August 2000	**Postdoctoral Researcher**	**Department of Chemistry Princeton University**
May 1994 – September 1998	**Research Assistant**	**National High Magnetic Field Lab Florida State University**
May 1993 – August 1993	**Research Assistant**	**Nuclear Research Building Florida State University**

Publications

1. "de Haas an Alphen Masurements of the electronic structure of $LaSb_2$", R.G. Goodrich, D. Browne, R. Kurtz, D.P. Young, J.F.Ditusa, P.W. Adams, and D. Hall, *Phys. Rev. B* **69**, 125114 (2004).
2. "Electronic Transport in EuB_6", G.A. Wigger, R. Monnier, H.R. Ott, D.P. Young, and Z. Fisk, *Phys. Rev. B* **69**, 125118 (2004).
3. "Weak ferromagnetism in CaB_6", M. C. Bennett, J. van Lierop, E. M. Berkeley, J. F. Mansfield, C. Henderson,M. C. Aronson, D. P. Young, A. Bianchi, Z. Fisk, F. Balakirev,and A. Lacerda, *Phys. Rev. B* **69**, 132407 (2004).
4. "New aspects of the temperature – magnetic field phase diagram of CeB_6", R.G. Goodrich, D.P. Young, D. Hall, Z. Fisk, N. Harrison, J. Betts, A. Migliori, F.M. Woodward, and J.W. Lynn, *Physical Review B* **69**, 054415 (2004).
5. "Large anomalous Hall effect in a silicon-based magnetic semiconductor", Ncholu Manyala, Yvan Sidis, John F. DiTusa, Gabriel Aeppli, David P. Young, Zachary Fisk, *Nature Materials* **3**, 255-262 (2004).
6. "Electronic properties of novel 4d metallic oxide $SrRhO_3$", K. Yamaura, Q. Huang, D.P. Young, M. Arai, E. Takayama-Muromachi, *Physica B* **329-333**, 820 (2003).
7. "Angle-resolved photoemission study and first principles calculation of the electronic structure of $LaSb_2$", Alice. I. Acatrinei, D. Browne, Y. Losovyj, D.P. Young, M. Moldovan, JuliaY. Chan, P. T. Sprunger, and Richard L. Kurtz, *J. Phys.: Condens. Matter* **15**, L511-L517 (2003).
8. "Magnetoresistance of electrodeposited FeCoNiCu/Cu multilayers",Q. Huang, D.P. Young, and E.J. Podlaha, *Journal of*

Applied Physics **94**, 1864 (2003).
9. "Synthesis, structure, and magnetism of a new heavy fermion – $CePdGa_6$", R.T. Macaluso, S. Nakatsuji, H. Lee, Z. Fisk, M. Moldovan, D.P. Young, and J.Y. Chan, *Journal of Solid State Chemistry* **174**, 296 (2003).
10. "Superconducting properties of $MgCNi_3$ films", D.P. Young, M. Moldovan, D. Craig, J.Y. Chan, and P.W. Adams, *Phys. Rev. B* **68**, 020501(R) (2003).
11. "High magnetic field sensor using $LaSb_2$", D.P. Young, R.G. Goodrich, J.F. DiTusa, S. Guo, and P.W. Adams, *Applied Physics Letters* **82**, 3713 (2003).
12. "Magnetic properties – parasitic ferromagnetism in the hexaborides? Reply", D.P. Young, Z. Fisk, J.D. Thompson, H.R. Ott, S.B. Oseroff, and R.G. Goodrich, *Nature* **420**, 144 (2002).
13. "Crystal structure and electronic and magnetic properties of the bilayered rhodium oxide $Sr_3Rh_2O_7$", K. Yamaura, Q. Huang, D.P. Young, Y. Noguchi, and E. Takayama-Muromachi, *Physical Review B* **66**, 134431 (2002).
14. "High-Pressure and High-Temperature Synthesis of a Novel Perovskite Compound: Magnetic and Electric Properties of the Rhodium Oxide $SrRhO_3$", K. Yamaura, D. P. Young, and E. Takayama-Muromachi, *Mat. Res. Soc. Symp. Proc.* **718** (2002) Material Research Society.
15. "^{11}B-NMR in CaB_6", J. L. Gavilano, Sh. Mushkolaj, D. Rau, H. R. Ott, A. Bianchi, D. P. Young and Z. Fisk, *Physica B* **312-313**, 813-814 (2002)
16. Electrodeposition of FeCoNiCu/Cu Compositionally Modulated Multilayers", Q. Huang, D. P. Young, J. Y. Chan, J. Jiang, and E. J. Podlaha, *Journal of The Electrochemical Society* **149** (6) C349-C354 (2002).
17. "Superconducting properties of BeB2.75", D. P. Young, R. G. Goodrich, and P. W. Adams, *Physical Review B* **65**, 180518(R) (2002).
18. "Elastic properties of ferromagnetic EuB_6", S. Zherlitsyn, B. Wolf, B. Luthi, M. Lang, P. Hinze, E. Uhrig, W. Assmus, H.R. Ott, D.P.Young, and Z. Fisk, *Euro. Phys. J. B* **22**, 327-333 (2001).
19. "Magnetic polarons and the metal-semiconductor transition in (Eu, La)B_6 and EuO: Raman Scattering Studies, C. S. Snow, S. L. Cooper, D. P. Young, Z. Fisk, Arnaud Comment, and Jean-Philippe Ansermet, *Physical Review B* **64**, (17) 4412 (2001).
20. "Fermi surface measurements on the low-carrier density ferromagnet $Ca_{1-x}La_xB_6$ and SrB_6", Donavan Hall, D. P. Young, Z. Fisk, T. P. Murphy, E. C. Palm, A. Teklu, and R. G. Goodrich, *Physical Review B* **64**, (23) 3105 (2001).
21. "Synthesis, structure, and superconducting in $BeB_{1.09}$", J. Y. Chan, F. R. Fronzcek, D. P. Young, and P. W. Adams, *Journal of Solid State Chemistry* **163**, 385-389 (2001).
22. "Fermi-surface measurements on the low-carrier density ferromagnet $Ca_{1-x}La_xB_6$ and SrB_6", D.P. Young, Z. Fisk, T.P. Murphy, E.C. Palm, A. Teklu, and R. G. Goodrich, *Physical Review B* **64**, 233105 (2001).
23. "Synthesis, crystal structure, magnetic, and electric properties of the cross-linked chain cobalt oxychloride Ba5Co5ClO13", K. Yamaura, D. P. Young, T. Siegrist, C. Besnard, C. Svensson, Y. Liu, and R. J. Cava, *Journal of Solid State Chemistry* **158** (2), 175-179 (2001).
24. Thermally induced variable-range-hopping crossover and ferromagnetism in the layered cobalt oxide $Sr_2Y_{0.5}Ca_{0.5}Co_2O_7$", K. Yamaura, D. P. Young, and R. J. Cava, *Physical Review B* **63** (2001).
25. "Enhancement of metallic behavior in bismuth cobaltates through lead doping", S. M. Loureiro, D. P. Young, R. J. Cava, R. Jin, Y. Liu, P. Bordet, Y. Qin, H. Zandbergen, M. Godinho, M. Núñ ez-Regueiro, and B. Batlogg, *Physical Review B* **63** (2001).
26. "Anomalous NMR spin-lattice relaxation in SrB_6 and $Ca_{1-x}La_xB_6$", J. L. Gavilano, Sh. Mushkolaj, D. Rau, H. R. Ott, A. Bianchi, D. P. Young, and Z. Fisk, *Physical Review B* **63**, 140410-1 – 3 (2001).
27. "Magnetic polarons and the metal-semiconductor transitions in (Eu,La)B[sub 6] and EuO: Raman scattering studies C. S. Snow, S. L. Cooper, D. P. Young, Z. Fisk, Arnaud Comment, and Jean-Philippe Ansermet, *Physical Review B* **64**, 174412 (2001).
28. "Band structure and thermoelectric properties of pure and doped Ag_3AuTe_2-a very low thermal conductivity material", D.P. Young, C.L. Brown, P. Khalifah, and R.J. Cava, *Journal of Applied Physics* **88**, (10) (2000).
29. "Electronic transport in $Eu_{1-x}Ca_xB_6$, S. Paschen, D. Pushin, M. Schlatter, P. Vonlanthen, H. R. Ott, D. P. Young, and Z. Fisk, *Physical Review B* **61**, 4174-4180 (2000).
30. "Unusual magnetism of hexaborides", H. R. Ott, J. L. Gavilano, B. Ambrosini, P. Vonlanthen, E. Felder, L. Degiorgi, D. P. Young, Z. Fisk, and R. Zysler, *Physica B* **281-282**, 423-7 (2000).
31. "Low-temperature NMR studies of SrB_6", J. L. Gavilano, B. Ambrosini, H. R. Ott, D. P. Young, and Z. Fisk, *Physica B* **281-282**, 428-9 (2000).
32. "A new mechanism for magnetoresistance in ferromagnets", N. Manyala, Y. Sidis, J.F. DiTusa, G. Aeppli, D.P. Young, and Z. Fisk, *Nature* **404**, 581-584 (2000).
33. "Development of the high-field heavy-Fermion ground state in $Ce_xLa_{1-x}B_6$", R.G. Goodrich, N. Harrison, A. Teklu, D.P. Young, and Z. Fisk, *Physical Review Letters* **82**, 3669-72 (1999).
34. "High-temperature weak ferromagnetism in a low-carrier free electron gas", D.P. Young, D.W. Hall, M.E. Torelli, Z. Fisk, J.L. Sarrao, J.D. Thompson, H.R. Ott, S.B. Oseroff, R.G. Goodrich, R. Zysler, *Nature* **397**, 412-14 (1999).
35. "Antimonides with the half-Heusler structure: New Thermoelectric Materials", K. Mastronardi, D.P. Young, C.-C. Wang, P. Khalifah, A.P. Ramirez, and R.J. Cava, *Applied Physics Letters* **74**, 1415-17 (1999).

BIOGRAPHICAL SKETCH			
Provide the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.			
Name Donghui Zhang		Position Title Assistant Professor	
EDUCATION (Begin with baccalaureate or other initial professional education and include postdoctoral training.			
INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Peking University, Beijing, P. R. China	B. S.	1998	Chemistry
Dartmouth College, Hanover, NH, USA	Ph.D.	2003	Chemistry
University of Minnesota, Minneapolis, MN, USA	Postdoc	2003-2005	Polymer synthesis

RESEARCH AND PROFESSIONAL EXPERIENCE: Starting with present position, list, in reverse chronological order, previous relevant employment, experience, and honors. Key personnel includes the principal investigator and any other individuals who participate in the development or execution of the project. Key personnel typically will include all individuals with doctoral or other professional degrees, but in some projects will include individuals at the masters or baccalaureate level provided they contribute in a substantive way to the development or execution of the project. Include present membership on any Federal Government public advisory committee. List, in reverse chronological order, the titles, all authors, and complete references to pertinent publications during the past five years and to representative earlier publications pertinent to this application. DO NOT EXCEED TWO PAGES.

RESEARCH INTERESTS

We are interested in the design, synthesis and application of functional materials (polymeric or molecular) to address issues that lie at the interface of synthetic chemistry, materials science and biomedical science and engineering. While the main focus of our research is the development of new synthetic methodologies, we also investigate relevant materials properties to facilitate transition to applications. The multidisciplinary nature of the program entails various modern synthetic techniques and physical characterization methods, and requires an understanding of biology and nanotechnology. Current research projects include development of catalytic reactions towards polymers with potential biomedical applications, design and synthesis of functional polymers or nano-composites with targeted end-uses (e.g. photoactive materials for optoelectronic devices, optical-magnetic sensors and biomedical implant materials).

PROFESSIONAL EXPERIENCE

Assistant Professor, 2007- present
Department of Chemistry, Louisiana State University, Baton Rouge, LA

Research Assistant Professor, 2005-2007
Department of Chemistry and Biochemistry, New Mexico State University, Las Cruces, NM

Postdoctoral Associate, 2003-2005
Department of Chemistry, University of Minnesota, Minneapolis, MN

PANELS SERVED/PROPOSAL REVIEWS

n/a

SELECTED PUBLICATIONS

1. Baesman, S. M.; Bullen, T. D.; Dewald, J.; Zhang, D.; Curran, S.; Islam, F. S.; Beveridge, T. J.; Oremland, R. S. "Formation of Tellurium Nanocrystals with Anaerobic Growth of Bacteria that use Te-Oxyanions as Respiratory Electron Acceptors." *Appl. Envir. Microbiol.* **2007**, *73*, 2135-2143.
2. Cech, J.; Kalbac, M.; Curran, S. A.; Zhang, D.; Dettlaff-Weglikowska, U.; Dunsch, L.; Yang, S.; Roth, S. "HRTEM and EELS Investigation of Functionalized Carbon Nanotubes." *Physica E: Low-Dimensional Systems & Nanostructures (Amsterdam, Neth.)* **2007**, *37*, 109-114.
3. Cech, J.; Curran, S. A.; Zhang, D.; Dewald, J. L.; Avadhanula, A.; Kandadai, M.; Roth, S. "Functionalization of Multi-Walled Carbon Nanotubes. Direct Proof of Sidewall Thiolation." *Phys. Status Solidi B: Basic Solid State Phys.* **2006**, *243*, 3221-3225.
4. Zhang, D.; Kandadai, M.; Cech, J.; Curran, S. A.; Roth, S. "Poly(L-Lactide) (PLLA) / Multi-Walled Carbon Nanotube (MWCNT) Composite: Characterization and Biocompatibility Evaluation." *J. Phys. Chem. B.* **2006**, *110*, 12910-12915.
5. Curran, S. A.; Zhang, D.; Wondmagegen, W. T.; Ellis, A. V.; Cech, J.; Roth, S.; Carroll, D. L. " Dynamic Electrical Properties of Polymer-Carbon Nanotube Composites: Enhancement through Covalent Bonding." *J. Mater. Res.* **2006**, *21*, 1071-1077.
6. Curran, S. A.; Cech, J.; Zhang, D.; Dewald, J. L.; Avadhanula, A.; Kandadai, M.; Roth, S. "Thiolation of Carbon Nanotubes and Sidewall Functionalization." *J. Mater. Res.* **2006**, *21*, 1012-1018.
7. Curran, S. A.; Zhang, D.; Dundigal, S.; Blau, W. "Doping Properties of Polydithienylmethine: a Study on the Correlation between Polymer Chain Length, Spectroscopy and Transport." *J. Phys. Chem.* **2006**, *110*, 3924-3929.
8. Curran, S. A.; Zhang, D.; Wondmagegen, W. T.; Blau, W. "Spectroscopic Studies of CSA-Doped Poly[C-hydroxyl-(4-N-dimethylamino)phenyl]dithienylmethine and Doping Effects on Ionic Conductivity." *Synth. Met.* **2006**, *156*, 482-487. (cover featured)
9. Curran, S. A.; Talla, J. A.; Zhang, D.; Carroll, D. L. "Defect Induced Vibrational Response of MWCNT Using Resonance Raman Spectroscopy." *J. Mater. Res.* **2005**, *20*, 3368-3373.

GRADUATE STUDENT COMMITTEES CHAIRED AT LSU

n/a

BIOGRAPHICAL SKETCH Provide the following information for the key personnel and consultants and collaborators. Begin with the Principal investigator/program director. Photocopy this page for each person.	
NAME: **Dr. M.A. Wahab**	POSITION TITLE: **Associate Professor**

EDUCATION (Begin with baccalaureate or other initial professional education and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
(1) Univ. of New Brunswick, Fredericton, Canada	**M. Eng. Sc.**	**1978**	**Mechanical Engineering**
(2) University of Alberta, Edmonton, Canada	**Ph.D.**	**1984**	**Mechanical Engineering**

EXPERIENCE:

01/02–pres.: Associate Professor, Mech. Eng., Louisiana State University, B'Rouge, USA.
11/01–01/02: Visiting Research Fellow, Kansai Univ. Civil Eng., Suita-Shi, Osaka, Japan
07/90–12/01: Senior Lecturer, Mech. Eng., Adelaide Univ. of Adelaide, Australia
07/88–06/90: Lecturer, Mech. Eng., Central Queensland Univ., Rockhampton, Australia.
01/86–07/88: Lecturer, Mech. Eng., Univ. of Tasmania, Hobart, Australia
07/85–12/85: Lecturer, Mech. & Production Eng., RMIT University, Australia.
09/76–07/84: Teaching/Research Asst., Uni. of New B'wick, Calgary, (Alberta-Edmonton), Canada.

SELECTED HONORS AND AWARDS:

(1) "Inter-wing Exchange Scholar", Uni. of Engineering and Technology, Lahore (1969- 1974).
(2) Teaching and Research Fellowship: Uni. of New Brunswick, Calgary and Alberta, Canada (1976 to 1984)
(3) AMPT '95 - International Prize" (**Bausch & Lomb Prize**) and **Best Technical Paper Award** at the Int. Conf. on the "Advances in Materials & Processing Technologies", Dublin, Ireland 1995.

PUBLICATIONS: (Dr. Wahab has published over 100 refereed journal & conference papers.)

***List of Five (5) Recent Peer-Reviewed Publications*:**

(1) M.S. Alam and **M.A. Wahab**, "Finite Element Modeling of Fatigue Crack Growth in Curved-Welded Joints Using Interface Elements," *J. of Structural Integrity and Durability*, Vol. 1, No. 3, Oct.(2005).
(2) **M.A. Wahab**, M.S. Alam, M.J Painter and P.E. Stafford, "Experimental and Numerical Simulation of Restraining Forces in Gas Metal Arc Welded Joint," *Welding Journal (Research Supplement)*, Vol. 85, No. 2, Feb. (2006).
(3) **M.A. Wahab**, J.H. Park, M.S. Alam and S.S. Pang, "Effect of Corrosion Prevention Compounds on Fatigue Life in 2024-T3 Aluminum Alloy," *J. of Material Processing Technology*, Vol. 174, pp. 211-217, May (2006).
(4) **M.A. Wahab**, M.S. Alam, S.S. Pang, J.A. Peck, and R.A. Jones, "Stress Analysis of Non-Conventional Composite Pipes, J. of Composite Structures, Vol. 79, pp 125-132, (2007),
(5) M.S. Alam, **M.A. Wahab**, and C.H. Jenkins, "Mechanics in Naturally Compliant Structures", Journal of Mechanics of Materials, Vol. 39, pp.145-160 (2007).

***List of Five (5) Other Peer-Reviewed Publications*:**

(6) M.H. Davies, **M.A. Wahab**, and M.J. Painter, "An Investigation of the Interaction of a Molten Droplet with a Liquid Weld-Pool Surface: A Computational and Experimental Approach," *Welding Journal-Research Supplement,* pp. 18s-23s, January (2000).

(7) **M.A. Wahab**, G.R. Rohrsheim, and J.H. Park, "Experimental Study on the Influence of Overload Induced Residual Stress Field on Fatigue Crack Growth in Aluminum Alloy," *J. of Materials and Processing Technologies,* Vol. 153-154C, pp. 945-951 (2004).

(8) **M.A. Wahab**, B.M. Saba, and A. Raman, "Fracture Mechanics Evaluation of a 0.5-MO Carbon Steel subjected to high temperature hydrogen attack," *J. of Materials and Processing Technologies*, Vol. 153-154C, pp. 938-944 (2004).

(9) M.S. Alam and **M.A. Wahab**, "Modeling of Fatigue Crack Growth and Propagation Life of Joint of Two Elastic Materials Using Interface Elements," *Int. J. of Pressure Vessel and Piping* , Volume 82, Issue 2, Pages 105-113, February 2005.

(10) **M.A. Wahab**, P.N. Sabapathy, and M.J. Painter, "The Onset of Pipewall Failure During "In-Service" Welding of Gas Pipelines" *J. of Materials & Processing Technology*, Vol. 168, pp. 414-422 (2005).

QUALIFICATIONS/EXPERIENCES RELEVANT TO THIS PROJECT:

Dr. Wahab was a founding member for Australian Cooperative Research Center for Materials Welding in Joining (CRC-MW&J) in 1992 where Australian Commonwealth Government injected $13.2M into Research and Education funds towards the Materials Welding and Joining. Dr. Wahab contributed extensively in both education and research programs of this CRC from 1992 to 2001 before joining LSU. Dr. Wahab has actively participated in ASRI (Australian Space Research projects) and supervised over 15-aerospace related projects from 1990 to 2001.

SYNERGISTIC ACTIVITIES:

Undergraduate Faculty Advisor and Mentor for about 25-students since 2002; International Advisory Committee Member for AMPT-Conferences in Dublin, Ireland; Reviewer for over 10 Journal Publishers in of Mechanical and Materials Engineering; External examiners for several PhD and M.S. Students in overseas countries.

RECENT UNDERGRADUATE RESEARCH STUDENTS AT LSU:

Supervised 8-undergraduate "Senior Design Projects" comprising of 25-graduating students and 5-undergradate research students at LSU. Prior to joining LSU I have supervised over 50-Final year "Design & Research Projects" comprising over 70 students.

COLLABORATORS *(outside LSU)*:

(1) Prof. S. Hashmi, Dublin City University, Dublin, Ireland, (2) Prof. S. Meguid, Uni. of Toronto, Toronto, Canada, (3) Prof. Alex Kalamkarov, Dalhousie University, Halifax, Canada, (4) Prof. F. Ellyin, Univ. of Alberta, Canada, (5) Prof. Deric Oehlers, Univ. of Adelaide, Australia, (6) Prof. Masahiro Sakano, Kansai University, Osaka, Japan

GRADUATE ADVISORS:

Prof. Donald G. Bellow, and Prof. M. Gary Faulkner of Uni. of Alberta, Edmonton Canada. (PhD), Prof. Huw. G. Davies, University of New Brunswick, F'ton, NB Canada. (Masters).

GRADUATE STUDENTS:

Current: B. Saba (PhD), D. Taylor (Masters), V. Raghuram (PhD); Prashanth Ramachandran
Completed: PhDs: A. Loghman, N. Nguyen, A,. Ghosh, M. Davies, P. Sabapathy, A. Dunston , D. Thompson, M. S. Alam ; **Completed Masters:** G.R. Rohrsheim,; G.R. Redden:; P. Chaplin, W. J.Y. Buttery, A. Smailes, P. Colegrove , J. Park, V. Gorugantu.

BIOGRAPHICAL SKETCH
Provide the following information for the key personnel and consultants and collaborators. Begin with the principal investigator/program director. Photocopy this page for each person.

Name Dongmei Cao	Position Title Director, Materials Characterization Center

EDUCATION (Begin with baccalaureate or other initial professional education and include postdoctoral training.

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	FIELD OF STUDY
Sichuan University, China	B.S	1996	Measurement and Control
Sichuan Univeristy, China	M.S	1999	Measurement and Control
Louisiana State University, USA	M.S.	2001	Mechanical Engineering
Louisiana State University, USA	Ph.D	2004	Mechanical Engineering
Louisiana State University, USA	Post-Doc	2005	Mechanical Engineering

Working Experiences

Nov. 2005 – Now, Director of Material Characterization Center, Mech. Eng. Dept. Louisiana State Univ., Baton Rouge, Louisiana

Sept. 2004 – Nov. 2005, Post-doc/ Mech. Eng. Dept., Louisiana State Univ., Baton Rouge, Louisiana

Awards and Notable Achievements

LSU Graduate School Certificate of Exemplary Achievement (College of Engineering Nominee for the 2004 LSU Distinguished Dissertation Award in Science, Engineering, and Technology).

Outstanding Research Assistant Award, 2004 ME Graduate Student Conference, Mech. Eng. Dept., Louisiana Sate Univ.

Demonstration of the first successful micromolding of aluminum with surface engineered metallic LiGA inserts (2003), Mech. Eng. Dept., Louisiana Sate Univ.

Outstanding Graduate Student Research Award (2001), Mech. Eng. Dept., Louisiana Sate Univ.

Pubications

D. M. Cao, J. Jiang, W. J. Meng, J. C. Jiang, W. Wang, "Fabrication of high-aspect-ratio microscale Ta mold inserts with micro electrical discharge machining", Microsystem Technol. Online First, July 6(2006).

D. M. Cao, J. Jiang, W. J. Meng, G. B. Sinclair, "Metal micromolding: further experiments and preliminary finite element analysis", Microsystem Technol. Online First, May 30(2006).

D. M. Cao, J. Jiang, R. Yang, W. J. Meng, "Fabrication of high-aspect-ratio microscale mold inserts by parallel μEDM", Microsystem Technol. Issue: Vol. 12, No. 9, 839(2006).

D. J. Kim, D. M. Cao, M. D. Bryant, W. J. Meng, "Tribological study of micro bearings for MEMS applications", Journal

of Tribology, Vol. 127, 537(2005).
W. J. Meng, D. M. Cao, G. B. Sinclair, "Stress during micromolding of metals at elevated temperatures: pilot experiments and a simple model", J. Mater. Res., Vol. 20, No. 1, 161(2005).

D. M. Cao, W. J. Meng, "Microscale compression molding of Al with surface engineered LiGA inserts", Microsystem Technol., Vol. 10, No. 8-9, 662(2004).

D. M. Cao, W. J. Meng, K. W. Kelly, "High-temperature instrumented microscale compression molding of Pb," Microsystem Technol. Vol. 10, No. 4, 323(2004).

D. M. Cao, D. Guidry, W. J. Meng, K. W. Kelly, "Molding of Pb and Zn with microscale mold inserts," Microsystem Technol. Vol. 9, No. 8, 559 (2003) .

D. M. Cao, W. J. Meng, S. J. Simko, G. L. Doll, T. Wang, K. W. Kelly, "Conformal deposition of Ti-containing hydrocarbon coatings over LiGA fabricated high-aspect-ratio micro-scale structures and tribological characteristics", Thin Solid Films 429, 46 (2003).

D. M. Cao, T. Wang, B. Feng, W. J. Meng, K. W. Kelly, "Amorphous hydrocarbon based thin films for high-aspect-ratio MEMS applications", Thin Solid Films 398/399, 553 (2001).

B. Feng, D. M. Cao, W. J. Meng, L. E. Rehn, P. M. Baldo, G. L. Doll, "Probing for mechanical and tribological anomalies in the TiC/amorphous hydrocarbon nanocomposite coating system", Thin Solid Films 398/399, 210 (2001).

B. Feng, D. M. Cao, W. J. Meng, J. Xu, R. C. Tittsworth, L. E. Rehn, P. M. Baldo, G. L. Doll, "Characterization of microstructure and mechanical behavior of sputter deposited Ti-containing amorphous carbon coatings", Surf. Coat. Technol. 148, 153 (2001).

D. M. Cao, B. Feng, W. J. Meng, L. E. Rehn, P. M. Baldo, M. M. Khonsari, "Friction and wear characteristics of ceramic nanocomposite coatings: titanium carbide/amorphous hydrocarbon", Appl. Phys. Lett. 79, 329 (2001).

W. J. Meng, R. C. Tittsworth, J. C. Jiang, B. Feng, D. M. Cao, K. Winkler, V. Palshin, "Ti atomic bonding environment in Ti-containing hydrocarbon coatings", J. Appl. Phys., 88, 2415 (2000).

CURRENT AND PENDING SUPPORT

(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **SHENGMIN GUO 1/4**

Status of Support: __**X**_Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **The Study of Colloidal Thrusters**

Source of Support: **NASA/LaSpace**

Award Amount (or Annual Rate): $___**25,245**______________ Period Covered:___ **06/2006-5/2008**___

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad __**0.5**___Summ

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Status of Support: __**X**_Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **The Study of a Single Stage to Space Rocket Engine Nozzle**

Source of Support: **LaSPACE HASP Student Payload Application**

Award Amount (or Annual Rate): $______**$22,000**___________ Period Covered:____ **01/2006- 12/2007**________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___ **1** __Acad _____Summ

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Status of Support: __ **X** _Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **A Plasma Spray System for Solid Oxide Fuel Cell Fabrication and Plasma Coating**

Source of Support: **BOR-Enhancement: LEQSF(2006-2007)-ENH-TR-13**

Award Amount (or Annual Rate): $________**$142,670**_________ Period Covered:___ **5/2006-6/2008**___________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad ___ _Summ **<5%**

Status of Support: _ **X** __Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **A High Speed Infra-Red Thermal Imaging and Flow Visualization System**

Source of Support: **LEQSF(2006-2007)-ENH-TR-08**

Award Amount (or Annual Rate): $____ **$197,000**____________ Period Covered:___ **5/2006-6/2008**____________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad __ ___Summ **<1%**

CURRENT AND PENDING SUPPORT

(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **SHENGMIN GUO 2/4**

Status of Support: __X_Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **A Real-Time, Stereoscopic Imaging System for Multi-Scale Applications**

Source of Support: **LEQSF(2006-2007)-ENH-TR-21**

Award Amount (or Annual Rate): $___**$177,000**______________ Period Covered:___ **5/2006-6/2008**___

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ **<1%**

Status of Support: __X_Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **Leading Edge Heat Transfer Coefficient Studies**

Source of Support: **Pratt & Whitney**

Award Amount (or Annual Rate): $______**32,500**___________ Period Covered:____ **01/2007-12/2007**________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___ __Acad _____Summ **<1%**

Status of Support: __ X _Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **NASA Student Design Project**

Source of Support: **NASA**

Award Amount (or Annual Rate): $_______**$8,100**_________ Period Covered:___ **08/2007- 08/2008**___________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad ___ _Summ **<2%**

Status of Support: _ X __Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **Dynamics and Hypersonic Flow of a Tethered System**

Source of Support: **Excalibur Almaz USA, Inc.**

Award Amount (or Annual Rate): $____ **$10,000**____________ Period Covered:___ **7/2007-7/2008**____________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad __ ___Summ **<2%**

CURRENT AND PENDING SUPPORT
(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **SHENGMIN GUO 3/4**

Status of Support: __**X**_Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **The Development of Novel Ceramic Nanofiber Sensors for Aerospace Application**

Source of Support: **LSU-FRG2007**

Award Amount (or Annual Rate): $___**$10,000**_______________ Period Covered:___ **7/2007-6/2008**___

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ **<3%**

Status of Support: __**X**_Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **Electro Spray Based Micro Reactor**

Source of Support: **Louisiana Board of Regents RCS**

Award Amount (or Annual Rate): $______**129,955+$46,442**_____ Period Covered:____ **6/2007 - 6/2010**________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___ **1**__Acad ___**1**__Summ

---

Status of Support: __ **X** _Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **Production of Ceramic Materials from Agricultural Waste**

Source of Support: **Louisiana Board of Regents ITRS**

Award Amount (or Annual Rate): $_____**$156,864+$66129+$61,000** Period Covered:___ **6/2007 - 6/2010**__________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___**1**__Acad ___**1**_Summ

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Status of Support: _ __Current __ **X** _Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **CAREER: Advanced High Power Density Fuel Cells**

Source of Support: **NSF**

Award Amount (or Annual Rate): $____ **$399,975**____________ Period Covered:___ **6/2008-6/2013**____________

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___**1**__Acad _ **1**___Summ

(Form 3, rev.2007)

CURRENT AND PENDING SUPPORT

(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **SHENGMIN GUO 4/4**

Status of Support: __ _Current _ **X** __Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **Metal-based microchannel heat exchange systems incorporating nanofluids**

Source of Support: **NSF**

Award Amount (or Annual Rate): $___**$ 396,628** ______________ Period Covered:___ **4/2008-4/2011**___

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___**1**__Acad ___**1**__Summ

---

Status of Support: __ _Current __ **X** _Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **Towards Combined Active Control of Film Cooling and Turbine Blade Aerodynamics**

Source of Support: **DOD/EPSCoR**

Award Amount (or Annual Rate): $______ **500,674** _____ Period Covered:____ **6/2008 - 6/2011**_______

Location of Activity: **LSU-BR**

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___ **1**__Acad ___**0.7**__Summ

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Status of Support: __ _Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $_____ Period Covered:___ ___________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad ____Summ

---

Status of Support: _ __Current __ _Pending ___Submission Planned in Near Future

Contract Number/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $____ _____________ Period Covered:___ _____________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad __ ___Summ

(Form 3, rev.2007)

CURRENT AND PENDING SUPPORT

(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **Dr. Young**

Status of Support: _X__Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **DMR-0449022 - CAREER: The synthesis and characterization of transition metal and lanthanide intermetallic strongly correlated electron systems**

Source of Support: **National Science Foundation**

Award Amount (or Annual Rate): $ 500,000 Period Covered: 06/2005 – 06/2010

Location of Activity: **Louisiana State University**

Person-Months or % of Effort Committed to the Project: _____Cal Yr __1.0___Acad __1.0___Summ

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Status of Support: _X__Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: **#32442 – FRG3: Energy Conversion and Storage Materials**

Source of Support: Louisiana Board of Regents: PKSFI

Award Amount (or Annual Rate): $ 171,875 Period Covered: 09/2007 – 09/2012

Location of Activity: Louisiana State University

Person-Months or % of Effort Committed to the Project: _____Cal Yr ___1.0__Acad __0.5___Summ

---

Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $__________ Period Covered:__________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

---

Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $__________ Period Covered:__________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

CURRENT AND PENDING SUPPORT

(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **Donghui (Catherine) Zhang**

Status of Support: ___Current __X_Pending ___Submission Planned in Near Future

Contract Number/Proposal Title:

Source of Support: Advanced Raman Spectroscope for Applied Chemistry Research and Development

Award Amount (or Annual Rate): $_______230, 457___________________ Period Covered:_______ 6/2008-6/2009____________

Location of Activity: Louisianan State University

Person-Months or % of Effort Committed to the Project: ___0__Cal Yr ___0__Acad ___0__Summ

---

Status of Support: ___Current ___Pending __ x _Submission Planned in Near Future

Contract Number/Proposal Title: Novel Routes towards Well-defined Nylonoid Polymers and Block Copolymers

Source of Support: American Chemical Society Petroleum Research Fund

Award Amount (or Annual Rate): $________50,000__________________ Period Covered:_____ 9/2008-8/2010______________

Location of Activity: Louisianan State University

Person-Months or % of Effort Committed to the Project: ___0__Cal Yr __0___Acad ___0__Summ

---

Status of Support: ___Current _x__Pending ___Submission Planned in Near Future

Contract Number/Proposal Title: Bio-Inspired Metal Mediated Catalysis Towards Poly-β-peptide

Source of Support: Louisiana State University Summer Stipend Program

Award Amount (or Annual Rate): $________5000__________________ Period Covered:_______ 7/2008-8/2008____________

Location of Activity:

Person-Months or % of Effort Committed to the Project: __0___Cal Yr __0__Acad __30%___Summ

---

Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Contract Number/Proposal Title:
Source of Support:
Award Amount (or Annual Rate): $_________________________ Period Covered:__________________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

CURRENT AND PENDING SUPPORT (Form 1001CP)
(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other key personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: Dr. M.A. Wahab, Associate Professor

Status of Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: "Development of Effective and Efficient Methods for Joining Composite Pipes," (PI: S.S. Pang, **Co-PIs: M.A. Wahab**, J.Q. Cheng, and G. Li)

Source of Support: Louisiana Board of Regents and EDO Fiber Science
Award Amount (or Annual Rate): $224,516. Period Covered: 06/01/07--06/30/10
Location of Activity: Louisiana State University
Person-Months or % of Effort Committed to the Project. Cal Yr: Acad: Sumr: 0.5

Status of Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: "Development of Unconventional Composite Pipes, Ducts, Joints, and Fittings for Low-to-Moderate Pressure Marine Applications," (**PI: M.A. Wahab**; Co-PIs: S.S. Pang, H.D. Jerro)
Source of Support: Louisiana Board of Regents and EDO Fiber Science
Award Amount (or Annual Rate): $200,000. Period Covered: 06/01/04 - 06/30/08
Location of Activity: Louisiana State University
Person-Months or % of Effort Committed to the Project. Cal Yr: Acad: Sumr: 1.0

Status of Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: "Comprehensive Mechanical Engineering Analyses of the Critical Components of Weaving Process Toward Achieving Size-Free Weaving," (PI: S.S. Pang; **Co-PIs:** K.V. Singh, Y.M. Ram, and **M.A. Wahab**).

Source of Support: U.S. Department of Agriculture
Award Amount (or Annual Rate): Period Covered: 02/01/05 - 12/31/07
Location of Activity: Southern University and Louisiana State University
Person-Months or % of Effort Committed to the Project. Cal Yr: Acad: 0.4 Sumr:

Status of Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: "Track 1, GK-12: National Science Foundation GK-12 Fellows Program at Louisiana State University," (PI: F.M. Neubrander; Co-PIs: S.S. Pang, I.M. Warner, L.F. Richardson, F.K. Cartledge; **Senior Personnel and Task Co-Leaders: M.A. Wahab**, S.S. Iyengar, S.Y. McGuire),
Source of Support: National Science Foundation (GK-12 Program)
Award Amount (or Annual Rate): $1,558,502. Period Covered: 05/01/05 - 04/30/08
Location of Activity: Louisiana State University, Baton Rouge
Person-Months or % of Effort Committed to the Project. Cal Yr: Acad: Sumr: 0.5

Status of Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: "Towards Miniaturization of the Naval Nuclear Propulsion Reactors: Novel Processing Routes of Fabricating Microstructures on Pressurized Water Reactors," (PI: S.I. Ibekwe, **Co-PIs:** G. Li, K. Lian, S.S. Pang, **M.A.Wahab**)
Source of Support: Department of Energy
Award Amount (or Annual Rate): $500,000. Period Covered: 10/01/05 - 09/30/07
Location of Activity: 10/01/05 - 09/30/07
Person-Months or % of Effort Committed to the Project. Cal Yr: Acad: 0.5 Sumr:

Status of Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future

Project/Proposal Title: "Smart Adhesively Bonded High-Performance Joint for Composite Structures," (PI: G. Li)

Co-PIs: S.S. Pang, **M.A. Wahab**, J.Q. Cheng)

Source of Support: NASA and Louisiana Board of Regents (EPSCoR Fund)

Award Amount (or Annual Rate): $1,434,000.00 Period Covered: 10/01/07--10/30/10

Location of Activity: Louisiana State University

Person-Months or % of Effort Committed to the Project. Cal Yr: Acad: Sumr: 1.0

CURRENT AND PENDING SUPPORT

(From ALL sources, including Board of Regents Support Fund)

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary.

NAME OF INVESTIGATOR: **Dongmei Cao**

Status of Support: __ **X** _Current ___Pending ___Submission Planned in Near Future Contract Number/Proposal Title: **Production of Ceramic Materials from Agricultural Waste** Source of Support: **Louisiana Board of Regents ITRS** Award Amount (or Annual Rate): $____**$156,864+$66129+$61,000** Period Covered:___ **6/2007 - 6/2010**__________ Location of Activity: **LSU-BR** Person-Months or % of Effort Committed to the Project: ___1__Cal Yr _____Acad ____Summ

(Form 3, rev.2007)

LOUISIANA STATE UNIVERSITY

Department of Mechanical Engineering

Louisiana State University
2508 CEBA
Baton Rouge, LA 70803-6413

O 225-578-5792
F 225-578-5924
http://me.lsu.edu

To: Board of regents, enhancement program

Dear manager of enhancement program:

Re: COST SHARING AND MATCHING COMMITMENTS
A QUANTUM-DESIGN PHYSICAL PROPERTY MEASUREMENT SYSTEM (PPMS) FOR NOVEL THERMOELECTRIC MATERIAL STUDIES

On behalf of the Department of Mechanical Engineering of Louisiana State University, I would like to express my strong support for the enhancement program proposal submitted by Dr. Shengmin Guo. I attest that his proposal is supported by, and integrated into, the educational and research goals of the department and the University. The acquisition of a PPMS system will beneficially impact the Mechanical Engineering Department and the Engineering College. It will enhance our research capability in the field of novel thermoelectric materials. The ME department, the College of Engineering, and the Office of Vice-Chancellor for Research and Economic Development will jointly provide $40,000 matching fund to support Dr.Guo's application. The Department of Mechanical Engineering will also provide one month salary, $10,807 with fringe benefit, to reduce the teaching load of Dr. Guo so he could work on this state-of-the-art system. The overhead for this Institutional Match is 47%. **Total support for this project is $74,686**.

The Department of Mechanical Engineering strongly supports Dr. Guo's proposal. The boost of an enhancement grant would greatly enhance the research and educational capability of the Mechanical Engineering Department and the College of Engineering.

Sincerely,

G.B. Sinclair
Juneau Professor and Chair of Mechanical Engineering
October 15, 2007

Quantum Design

CORPORATE HEADQUARTERS
6325 LUSK BOULEVARD
SAN DIEGO, CA 92121-3733
USA

TEL: 858.481.4400
800.289.6996
FAX: 858.481.7410
E-MAIL: info@qdusa.com
http://www.qdusa.com/

QUOTATION

TO: Dr. Shengmin Guo
Louisiana State University

Phone: 225 578 7619
Email: Sguo2@lsu.edu

Quantum Design
6325 Lusk Blvd. San Diego, CA 92121
Phone: 858-481-4400 Fax 858-481-7410
www.qdusa.com
DATE: October 17, 2007

Quotation No.: Q-DP071017-01

QTY	MODEL	DESCRIPTION	PRICE
1	PPMS-7	PPMS Base System with a 7 Tesla Long. Magnet & Power Supply	$126,550
1	P400	Resistivity Option	N/C
1	P600A	AC Transport Property Measurement System (ACT)	$13,970
1	P650	Heat Capacity Measurement System (HC) (Includes P640)	$54,020
1	P670	Thermal Transport System (TTO) (Requires P400, P600, and P640)	$16,610
1	P925A	High Capacity Nitrogen Jacketed Dewar Upgrade	$6,940
1		Shipping/Handling	$3,000
	Total		$221,090.00

Terms: FOB San Diego (freight charges included).
State & local taxes & fees responsibility of purchaser.
Payment: Net 30 days following shipment.
Validity: This Quotation is valid for a period of 60 days.
Note: Equipment configured for 110VAC, 60 Hz, 15 Amps.

Daniel Polancic
North American Sales Manager
QUANTUM DESIGN