**PARTICLES, PROCESSES AND MATERIALS FOR MODERN ENERGY NEEDS:
DEVELOPMENT OF A DOE-EPSCoR PROJECT IN PUERTO RICO**

FINAL REPORT FOR

September 30, 1997 – August 31, 2000

Dr. Brad R. Weiner

**University of Puerto Rico
Resource Center for Science and Engineering
PO Box 23334
UPR Station
Rio Piedras, PR 00931-3334**

**Prepared for
THE US DEPARTMENT OF ENERGY
AWARD NO. DE-FGO2-94ER75764**

DOE Patent Clearance Granted

4/10/03
Date

Daniel D. Park

(630) 252-2308
E-mail: daniel.park@ch.doe.gov
Office of Intellectual Property Law
DOE Chicago Operations Office

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ABSTRACT

Twenty-eight (28) faculty researchers focused on High Energy Particle Physics, Novel Thin Film Materials for Optoelectronic Applications, and Catalytic Processes for Energy Sources and Environmental Detoxification to address problems cited as priorities by the DOE and local agencies. The High Energy Particle Physics cluster has DOE-competitive funding and the number of cluster investigators who have competitive mainstream funding has increased from 2 to 13 since the inception of the program. In this reporting period, 8 postdoctorals, 38 graduate students and 23 undergraduates were involved in DOE projects and 191 publications and 238 presentations were generated. The UPR-Arecibo Integrated Science Multi-Use Laboratory provided workshops and other activities that directly impacted 360 teachers and 600 students and indirectly impacted over 25,000 through the enhancement of teachers' skills and knowledge.

1. Executive Summary

EXECUTIVE SUMMARY

The Puerto Rico Department of Energy Experimental Program to Stimulate Competitive Research (PR-DOE/EPSCoR) was initiated on 30 September 1994 for a two year period, renewed for a third year in July 1996 and renewed again in September 1997. Three research clusters with a total of twenty-eight (28) faculty researchers focused on High Energy Particle Physics, Novel Thin Film Materials for Optoelectronic Applications, and Catalytic Processes for Energy Sources and Environmental Detoxification and worked towards innovative solutions to problems of national Department of Energy priorities, as well as those of local needs. In this reporting period the program maintained a strong student research participation, with eight (8) postdoctorals, thirty-eight (38) graduate students and twenty-three (23) undergraduates directly involved in the project and still more worked on related projects. Student participation will assist in providing future human resources for Puerto Rico to address energy-related issues. The participation of individuals ranging from senior level faculty to undergraduate students has strengthened research opportunities at all levels in the higher education institutions in Puerto Rico.

In addition to graduate and undergraduate education opportunities, PR-DOE/EPSCoR has developed an active Human Resources component to promote scientific literacy and motivate K-12 students to pursue scientific careers. A collaborative program with the Puerto Rico Department of Education to send researchers to junior high and high school classrooms to explain their research and their role as scientists was well received by teachers and students. Curriculum development was also an important means of stimulating more students into careers as scientists. An Integrated Science Multi-Use Laboratory, funded under this grant, was constructed on the Arecibo campus of the University of Puerto Rico. It has had and continues to have a significant impact on curriculum development by allowing teachers to develop (with guidance) their own instruction materials. Workshops were and are held on a continuing basis and teacher/student/faculty response has been positive, with activities directly impacting 360 teachers and 600 students and over 25,000 indirectly through the enhancement of teachers' skills and knowledge.

PR-EPSCoR played and continues to play a central role in the creation and operation of a Science and Technology Authority in Puerto Rico. Dr. Manuel Gómez, Project Director of PR-NSF/EPSCoR and Co-Project Director of PR-DOE/EPSCoR, helped to create the New Economic Development Model as a blueprint for achieving competitive high tech industrial development on the island. Two focal points of the New Economic Development Model are human resources development in Science, Engineering and Mathematics (SEM) and advancement of an R&D base connected to high tech industrial growth. In 1995, the Commonwealth Government established a Council for the Development of Science and Technology Policy that has members from academia, industry and government as the source of broad policy for scientific research and development in Puerto Rico. The Council was developed with the active participation and leadership of PR-EPSCoR and the President of the University of Puerto Rico. In 1996, the Governor of Puerto Rico signed the Science and Technology Policy for Puerto Rico written by the Council.

2. Management and Coordination

INTRODUCTION

Puerto Rico-Department of Energy/Experimental Program to Stimulate Competitive Research continues towards its goal to establish a permanent presence of energy-related research in Puerto Rico through the development of a productive environment for the achievement of national standards of excellence in energy-related research. PR-DOE/EPSCoR is having a profound impact on the advancement of Science, Engineering and Mathematics (SEM) research on the island. The effect was achieved through the coherent development of three research clusters of excellence which serve as the foundation for energy-related research and the development of human resources in energy research, thus transforming the past state of fragmentation and lack of significant activity in this area. Participating academic departments have been noticeably strengthened, particularly through the increased availability of research opportunities for undergraduate and graduate students and through the enrichment of curricula by incorporating energy research into existing courses and developing new courses in energy-related areas. The substantial commitment of the DOE and University of Puerto Rico resulted in the purchase of over \$500,000 in permanent equipment that will have a lasting effect on the research community. In addition, PR-DOE/EPSCoR played and continues to play a significant role in increasing the numbers of minority students graduating with Ph.D.s in SEM, with the rate moving from an average of 12 to 26.

The Commonwealth of Puerto Rico, a 3,450 sq. mile island with a population of 3.8 million Hispanic Americans has an average population density of over 1000 people per square mile, but the number of individuals per square mile in the San Juan metroplex is much larger. Demand for electricity in Puerto Rico is expected to be nearly 3,300 MW in 2004. To meet future demands for energy, the Puerto Rico Electric Power Authority (PREPA) which currently relies on imported oil to produce up to 99% of the electricity consumed, will require the development of other low-cost and environmentally sound energy alternatives. The island's capability for addressing these energy needs will be crucial for its future economic development. The island's economy has been transformed drastically during the past four decades, as agricultural-based production has given way to high tech industries, mostly comprised of pharmaceutical, electronics/computer and medical technology companies.

PR-DOE/EPSCoR constitutes a major component of the strategy to achieve the Commonwealth's goals for building its scientific base by strengthening the capability of the island's graduate level research universities. The program has stimulated strong student research participation, with eight (8) postdoctorals, fifty-eight (38) graduate students and twenty-three (23) undergraduates funded in the project, and still more working on related projects through other funding. PR-DOE/EPSCoR also developed an active Human Resources component geared towards the promotion of scientific literacy and motivation towards scientific careers at the K-12 level. This participation will help supply Puerto Rico with the human resources for dealing with energy-related problems. Three research clusters (High Energy Particle Physics, Novel Thin Film Materials for Optoelectronic Applications, and Catalytic Processes in Energy Sources and Environmental Detoxification) were established with a total of 28 faculty researchers, 13 of whom now have competitive funding. The establishment of the research clusters together with active student participation led to significant scientific and technical accomplishments. Over 300

publications in refereed journals and nearly 400 presentations in national and international forums have resulted from PR-DOE/EPSCoR researchers since the inception of the project, with 191 publications and 238 presentations having been generated in this reporting period. The University of Puerto Rico committed \$6.0 million (cash) for the development of the PR-DOE/EPSCoR during the 1994-2000 period. This is in addition to in-kind contributions such as release time, equipment maintenance and support personnel.complishment

Highlights of PR-DOE/EPSCoR

Listed below are some of the most notable accomplishments from 1994-2000 that have had a significant impact on the development of energy-related science in Puerto Rico.

- ☐ Establishment of three research clusters, comprised of 28 research faculty, focused toward the solution of energy-related problems of national and local interest; one of these clusters (High Energy Particle Physics) has DOE-competitive funding to continue; the other two have not been funded as research clusters but many of the researchers have received competitive funding to continue work initiated under DOE/EPSCoR;
- ☐ Publication of 300 refereed journal articles since the inception of the project that are directly attributable to PR-DOE/EPSCoR funding; furthermore, the percentage of DOE-related papers coming out of these research groups has been significantly enhanced, clearly demonstrating a presence for energy-related research in Puerto Rico;
- ☐ Creation of a Science and Technology Authority in Puerto Rico that has developed a Science and Technology Policy for the Island that was signed by the Governor;
- ☐ Installation of a High Energy Particle Physics laboratory facility in Puerto Rico; the Puerto Rican team has taken a leadership role in the planning and development of new experiments at Fermilab;
- ☐ Active involvement of over 75 graduate students, and 40 undergraduates in energy-related research;
- ☐ Increased collaborations, at all levels, with the Department of Energy National Laboratories; several UPR faculty are publishing regularly with National Lab researchers;
- ☐ Held a workshop for representatives of National Laboratories to meet with research personnel in Puerto Rico; this led to the development of stronger research collaborations for both EPSCoR and non-EPSCoR university faculty;
- ☐ Creation of the Integrated Science Multi-use Laboratory for Teacher Training at the Arecibo University College; this facility has continued to receive accolades from many sectors as a National model for teacher training;
- ☐ Increase in the amount of competitive funding to PR-DOE/EPSCoR researchers; 13 of the 28 researchers in DOE/EPSCoR now have competitive mainstream funding, whereas only two of them did at the inception of the program.

MANAGEMENT AND COORDINATION

Due to the large size and complexity of the PR-DOE/EPSCoR, the management structure must be well-organized and efficient to optimize efforts and achieve synergy in the program. The Project Director, Dr. Brad R. Weiner, Professor of Chemistry in the College of Natural Sciences of the Rio Piedras Campus, assured the effective implementation of the plan and the achievement of the objectives, providing leadership for the PIs of the three research clusters and working

closely with them on the achievement of their strategic objectives. The Project Director responded directly to the President of the University of Puerto Rico, thus assuring the support of the top executive official of the University System. Dr. Manuel Gomez, Co-Project Director of PR-EPSCoR, Director of the Resource Center for Science and Engineering (RCSE) and Professor of Physics at the Rio Piedras College of Natural Sciences, and Dr. Angel Lopez, from the Department of Physics of the Mayaguez Campus, served as Co-Project Directors for the DOE/EPSCoR and worked with Dr. Weiner in implementing the research and human resource development plans and in monitoring progress. Dr. Lopez was the administrative link to the Mayaguez campus. Dr. Weiner was aided in the day-to-day administration of the project by the Project Coordinator, Irma Febo. The Project Directors were aided in the development of the project, particularly with respect to technical matters, by a Steering Committee composed of the principal investigators of the three research clusters and one of the Co-PDs from the Human Resources Development component. The EPSCoR State Committee, the policy making body for the long-term development of the island's scientific infrastructure and human resources, provided oversight of the progress and formulated global policies to support the development of PR-DOE/EPSCoR, promoted integration with the state's economic development plan as well as with other EPSCoR projects, and assured the achievement of long term goals.

Outstanding members of the national scientific community with special expertise in fields related to the research clusters and including scientists from National Labs constituted an External Advisory Board for the PR-DOE/EPSCoR program. The Board met with the PIs on an annual basis to review the progress of the research clusters and human resources development component and provided recommendations for further development of the clusters as well as for the overall performance and long-term strengthening of the project. The Board provided the PI's and the PR-DOE/EPSCoR State Committee a written report delineating major findings and recommendations that were used as a basis for improving the program.

Below is a list of the seven (7) members of the PR-DOE/EPSCoR External Advisory Board.

George W. Kabalka Professor and Director of Research, Department of Radiology
University of Tennessee Medical Center Knoxville 7124 Cresthill Drive
Knoxville, TN 37919-5910
Email: kabalka@novell.chem.utk.edu

Michael E. Sigman Research Associate III, Chemistry Division Oak Ridge National Lab PO Box 2008
Building 4500-S, MS 6100
Oak Ridge, TN 37831-6100 Tel: (423) 576-2173
Email: sigmanme@ornl.gov

William Woodruff Los Alamos National Laboratory CST-14, Mail Stop C345 Los Alamos, NM 87545 Tel: (505) 665-2557
Email: woody@lanl.gov

Irwin Gaines Fermi National Accelerator Lab PO Box 500
Batavia, Illinois 60610
Email: gaines@fnal.gov

William M. Yen Graham Perdue Chair of Physics and Professor Department of Physics and Astronomy University of Georgia \

Athens, GA 30602-9986 Tel: (706) 542-2485

Email: wyen@hal.physast.uga.edu

Nestor Ortiz Sandia National Laboratories Nuclear Energy Technology Organization 6400

Bldg. 823, Room 3092

Albuquerque, NM 87185-5800 Tel: (505) 844-0577

Email: nrortiz@sandia.gov J

Nonnan D. Peterson Argonne National Laboratory 9700 South Cass Avenue Argonne, IL 60439

Tel: (630) 252- 7229

Email: npeterson@smtpgate.anl.gov

PERSONNEL

PR-DOE/EPSCoR, a multidisciplinary effort, involved twenty-eight (28) faculty researchers from the UPR, eight (8) postdoctoral research associates, fifty (50) graduate students and twenty-two (22) undergraduates. Tables 1-7 list the personnel directly involved in PR-DOE/EPSCoR.

Table I. Management and Coordination -Senior Personnel

Name	Position	Percent Effort
Brad R. Weiner	Project Director	20%
Angel M. Lopez	Co-Project Director	15%
Manuel Gomez	Co-Project Director	10%
Angel M. Lopez	Principal Investigator	25%
John A. Soderquist	Principal Investigator	25%
Nelson Cardona	Principal Investigator	25%
Ram S. Katiyar	Principal Investigator	25%
Zulma Crespo	Project Coordinator	100%
Sandra Troche	Administrative Assistant	100%

Table 2. Human Resources Development Cluster -Senior Personnel

Name	Position	Percent Effort
Effort Ibis L. Aponte	Senior Investigator	25%
Javier Figueroa	Senior Investigator	12.5%
Carlos Pérez	Senior Investigator	12.5%
Abel Mendez	Senior Investigator	12.5%
Norma Davila	Evaluator	12.5%
Juan Lopez Garriga	Senior Investigator	12.5%
Daniel Mora	Technician	100%
Manuel Gomez	Principal Investigator	See M&C
Brad R Weiner	Principal Investigator	See M&C

Table 3. High Energy Physics Cluster -Senior Personnel

Name	Position	Percent Effort
Angel M. Lopez	Principal Investigator	See M&C
Wolfgang Rolke	Senior Investigator	12.5%
Weinjun Xiong (0217/99-02/15/00)	Postdoctoral Associate	100%

Table 4. Novel Thin Film Materials for Optoelectronics Applications Cluster -Senior Personnel

Name	Position	Percent Effort
Ram S. Katiyar	Principal Investigator	See M&C
Fouad M. Aliev	Senior Investigator	15%
Felix Fernandez	Senior Investigator	15%
Luis F. Fonseca	Senior Investigator	15%
Weiyi Jia	Senior Investigator	15%
Huimin Liu	Senior Investigator	15%
Antonio Martinez	Senior Investigator	15%
Pramod Singh Dobal (09/30/98-11/14/99)	Postdoctoral Associate	100%
Subhasish Majumder (4/21/98-1/31/99)	Postdoctoral Associate 1	100%
Sathiraju Srinivas (07/27/98-05/31/99)	Postdoctoral Associate	100%

Table 5. Catalytic Processes for Energy Sources and Environmental Detoxification Cluster-Senior Personnel

Name	Position	Percent Effort
John A. Soderquist	Principal Investigator	See M&C
Nelson Cardona	Principal Investigator	See M&C
Rafael Arce	Senior Investigator	15%
Lesser Blum	Senior Investigator	15%
Carlos R. Cabrera	Senior Investigator	15%
Miguel E. Castro	Senior Investigator	15%
Jorge L. Colon	Senior Investigator	15%
Jose A. Colucci	Senior Investigator	15%
Juan Lopez Garriga	Senior Investigator	15%
Ana R. Guadalupe	Senior Investigator	15%
Songping Huang	Senior Investigator	15%
Edwin Quifiones	Senior Investigator	15%
Brad R. Weiner	Senior Investigator	5%
K. Ganeshwar	Postdoctoral Associate	100%
(08/4/98-06/30/99)		
Yitzu Guo	Postdoctoral Associate	100%
(10/3/98-2/28/99)		
Chibiao Liu	Postdoctoral Associate	100%
(08/17/98-3/31/99)		
Makarov Vladimir	Postdoctoral Associate	100%
(10/19/98-04/30/99)		

Total number of publications, presentations and patents in this reporting period

	Directly Attributable DO E- EPSCoR	Other
Publications		
• Cluster I	3	--
• Cluster II	153	90
• Cluster III	30	22
<i>Total</i>		
Presentations		
• Cluster I	17	--
• Cluster II	126	60
• Cluster III	58	46
<i>Total</i>		
Patents		
• Cluster I	--	--
• Cluster II	3 pending/ 3 Disclosures	0
• Cluster III	--	--
<i>Total</i>		--

Cluster I: High Energy Physics Cluster

Cluster II: Novel Thin Film Materials for Optoelectronics Applications

Cluster III: Catalytic Processes for Energy Sources and Environmental Detoxification

MAINSTREAMING

One of the primary goals of the EPSCoR project in general is to move research faculty into competitive mainstream funding. In order to motivate this activity, we have asked all researchers in PR-DOE/EPSCoR to send competitive research grants to the major federal agencies. Thus far, we have had only two submissions to the Department of Energy competitive programs, one of which one was funded. We implemented a policy of withholding summer compensations for any faculty members who do not publish their research results related to the DOE-EPSCoR grant.

NEW INITIATIVES

One of the thrust areas of Puerto Rico EPSCoR is High Performance Computing. From time to time this area of research has been infused with support from the Commonwealth of Puerto Rico, the National Science Foundation and the Department of Defense. Because the development of High Performance Computing is critical for the ongoing development of research in Puerto Rico, some PR-DOE/EPSCoR funds were used to hire Dr. Guy Cormier, a Computational

Materials Scientist, to develop a High Performance Computing Facility at the University of Puerto Rico. The funds came from savings through other parts of the proposal. Dr. Cormier's leadership has resulted in greatly enhancing the facility and services. To minimize resource duplication and facilitate cost-effective resource management, various components of the HPCf are integrated, including: (a) the Center for Numerical Supercomputing; (b) the Distributed Visualization Laboratory; (c) the Resource Center for Bioinformatics; and (d) the Teaching Laboratories and Access Nodes. Underlying these computational resources is the Internet2 Project that brings high bandwidth connectivity to the Río Piedras, Mayagüez and Medical Sciences UPR campuses and the Arecibo Observatory. The center of this network, the PRISA GigaPoP, offers superlative access to HPCf computers. The range of supported users is wide and includes 36 ongoing research projects. The technology infrastructure and related services include: 1) Core High Performance Computational Resources; 2) Advanced Research Network (the Internet2 Project in PR); 3) Services in Support of Users of Computational Resources; 4) Evaluation and Promotion of Standards and Architectures; and 5) Evaluation of Emerging Hardware and Software Technologies.

Services to support use and users include, 1) Workshops on bioinformatics, visualization, programming and Unix system administration; 2) Joint development or adaptation of Internet2 meritorious applications; 3) Software development, especially for parallel programming; 4) Development of research materials at the Visualization Laboratory; and 5) Network design and security consulting.

3. Human Resources Development

INTRODUCTION

The Human Resources Development component of Puerto Rico's DOE-EPSCoR project has carried out a series of activities since 1994 aimed at increasing the number of junior and senior local scientists and engineers involved in energy-related research. These activities touch all levels of the educational and research structure from pre-college to senior researcher but emphasize the development of young minds through activities aimed at the pre-college level, including a teacher training laboratory, school visits by researchers, and Saturday academies for teachers and students. Other activities such as Summer Internships for undergraduate students complement the human resource development that occurs in research clusters as junior researchers, postgraduate assistants, graduate and undergraduate students, and senior research faculty are immersed in the work of leading-edge projects.

INTEGRATED SCIENCE MULTI-USE LABORATORY FOR TEACHER TRAINING

The broad objective of the ISMuL is to update and enhance the quality of basic science education as a means to encourage more students to follow careers in SEM. As a strategy the ISMuL promotes the creation of and incorporation into pre-college and college curricula activities that engage faculty and students in meaningful problems. The intent is to offer educational experiences that foster higher thinking skills, provide valid ideas about science, engender a spirit of inquiry and investigation, and motivate students to pursue science. The ISMuL mission is to:

- Provide training, continuous education, research opportunities and resources to science teachers at the Junior and High School levels.
- Encourage and support research and the development of curricular enhancement projects for both pre-college and college faculty and students.
- Create a Spanish language bank of pre-college and college level curricular materials that provide an integrated view of science.
- Provide the infrastructure in the Arecibo College for a Baccalaureate program in Science Education.

The ISMuL consists of: (1) a workshop room, computer area with a small PC network with advanced multimedia capabilities; (2) a production room with a server to create interactive software; (3) a laboratory-scale machine shop area to design and construct simple equipment for demonstrations and hands-on experiences; (4) an electronics bench to support the machine shop area; (5) office and storage areas. The computer and workshop equipment was chosen to match that available at some schools in the PR-Department of Education (PR-DE). With these capabilities the ISMuL provides workshops in basic science content, effective teaching techniques and prevailing philosophies, as well as the use of equipment. The chief goal is to motivate and provide support for teachers and college faculty to go beyond the workshop experience to develop projects, create educational software and/or devices at these facilities. Besides offering formal training experiences, the ISMuL aims to serve as an experimental center where teams of college professors and students, along with school teachers and students can join

ventures in research on science education and the creation of innovative curricular material, custom-made to respond to their particular needs.

Effective liaisons have been made with PR-SSI, the Institute of Continuous Education (ICE) and the AMP programs of the RCSE that have provided access to the PR-DE and additional funds. Two intensive summer workshops were offered to Junior-High teachers at the San Juan and Arecibo districts. Three college courses have been revised to introduce inquiry activities, alternative assessment and cooperative learning. The ISMuL is included as a pilot project and collaborator in the latest ICE project. The ICE and the ISMuL targeted High-School science teachers to provide the proper overlap with PR-SSI. A college physics laboratory manual and an Electronic Laboratory Notebook (ELaN) were prepared in collaboration with a faculty member of the Aguadilla College (also part of the UPR Administration of Regional Colleges, ARC).

ISMuL's PRE-COLLEGE LEVEL ACHIEVEMENTS

From 1997-2000 ISMuL activities directly impacted 360 teachers and almost 600 students; through the training of 360 teachers over 25,000 students were indirectly impacted. Below is a representative sample of the types of workshops offered.

Rediscovering Mathematics--This 15 hour workshop for elementary-high school teachers covered difficult concepts such as fractions, percent, formulas, two-dimensional and three dimensional geometric figures, and their construction using bars and web models. At the end of the workshop, teachers were responsible for designing and presenting a learning activity at the grade level they teach. In the semester following the workshop, pre-service teachers from UPR-Arecibo were invited to observe the workshop participants present activities they had developed at or following the workshop.

Visits to the Planetarium at UPR-Mayagüez - A series of 1.5 hour visits to the Mayagüez Planetarium allowed teachers to become acquainted with the facilities and the functioning of the planetarium. The following topics were discussed: how to present the corresponding night sky as observable from Puerto Rico the day of the visit, how to identify the geographic north using stars as points of reference, how to present a real-time model of the solar system, how to identify zenith and ecliptic, and a description of the outstanding characteristics of the planets in the Solar System.

Awakening Interest - This activity addressed issues faced by first year education students at UPR-Arecibo. Through group dynamics and lectures students dealt with topics such as study techniques, self-esteem and motivation. Students participated in a discussion following a presentation entitled *Why do I want to be a teacher?* They also discussed the importance of scientific research in the field of education. Four UPR Arecibo faculty members participated in the workshop.

Portfolio as a Tool - This Workshop analyzed the function and usefulness of the portfolio concept in the evaluation of student learning. The design and structure of portfolios were discussed, including a list of possible types of documents that can be evaluated in a particular course.

My Way – A science teacher presented the design for two activities that include the use of graphic calculators and CBLs at the middle school level. A Physics and Chemistry Department professor at UPR-Arecibo introduced the use of the graphic calculator and CBL's. Participants engaged in hands-on activities that included measuring acidity in some common antacids and determining the caloric content of a nut. Only low-cost materials were used. All the measurements were taken with the CBL's pH and temperature sensors and computations were performed with a TI-86 graphic calculator.

Peer-led Team Learning - Some twenty participants, including teachers, education students and college faculty, were exposed to peer-learning as a teaching-learning strategy. The workshop leaders and students teachers from UPR-Arecibo described and demonstrated the techniques they use in their courses.

Astrobiology: The Study of Life in the Universe - In this interactive seminar a group of middle school students and their teachers were given an overview of what astrobiology studies entail. A study of the planet Mars was used to exemplify the multidisciplinary approach to this field. Participants viewed images and a video of the planet's surface via computer 3-D virtual images. The activity also included hands-on computer experiences using the Internet to search for information regarding space exploration in NASA WebPages. They also had the opportunity to look at pictures (with 3-D glasses) of Mt. Fuji in Japan taken from the space shuttle.

Aeronautics Education Laboratory - ISMuL became the 16th replication site, the first one outside the continental U.S., of the Aeronautics Education Laboratory. The state-of-the-art classroom includes ten workstations that permit students to explore various technologies used in the field of aviation today. The activities and curriculum support the national math and science standards and process skills, with applications to real-world careers. Students are encouraged to explore careers in technology, engineering and science through this special focus on the field of aeronautics. ISMuL offers workshops to middle school teachers and their students in which participants plot a trip from California to Washington, D.C., passing through all the NASA Field Centers.

When the Earth Trembles – Twenty-five K-12 science and mathematics teachers participated in this twenty hour (four Saturdays) workshop on the basics of earthquakes. On the first Saturday, a general theoretical background of plate tectonics and the physics of seismic waves is presented by an expert resource from The Puerto Rico Seismic Network at Mayagüez. The second Saturday another expert from the Network provides a historical summary of the seismic events in Puerto Rico up to the present day. The third Saturday is devoted to discussing the social implications of an earthquake and how the extent of disaster is determined by the degree of vulnerability of society. An expert from the State Agency for Emergency Management discusses structural and non-structural risks and emphasizes the need for each school to establish a local emergency management program that can respond immediately to an earthquake. The last Saturday is devoted to visiting the facilities of the Puerto Rico Seismic Network, where a data analyst guides participants through a series of activities designed to teach them how to calculate

seismic parameters such as magnitude, intensity, event duration, epicenter and others. After completion of the workshop each participant receives a safety back-pack full of articles needed to begin the organization of a School Seismic Alert Program(SSAP). ISMuL monitors this program during the first two years to make sure that the program is established and that it can continue alone after that.

Aeronautics Education Laboratory (AEL) Workshops for teachers - This four hour workshop is for teachers who plan to bring a group of students to the AEL facilities, preparing them to: a) discuss some basic terms in aeronautics with the students before their visit b) become acquainted with the equipment and curriculum of the laboratory c) motivate their students in group work before their visit and find out what their feelings are regarding the study of science and mathematics d) help their students after their visit in the design and implementation of one or more activities based on their experience at AEL and e) share activities and materials with other teachers. At this workshop the date for the visit of each teacher with his(her) students is assigned. In general, teachers get a whole idea of the complete experience their students will have at AEL at the same time they understand the key role they play in students' experience.

(Doña Ignacia no está aquí, está en su vergel!) - In a three hour workshop, Mrs. Ignacia Olivero shared her experiences in developing activities using plants from her seedbed. She made suggestions about other low cost projects and urged new teachers to construct a seedbed in their schools.

Graphic Calculator Use - In a four hour workshop, Prof. Edwin Morera from UPR-Cayey discussed and provided hands on experiences in using the graphic calculator to do basic operations, solve basic problems in mathematics using the graphical approach the CBL= sensors and analyzing data from an experiment.

Trip to the Planetarium at Mayagüez - This 1.5 hour visit to the Mayagüez Planetarium was to become acquainted with the facilities and functions of the planetarium. The following topics were discussed: how to present the corresponding night sky as observable from Puerto Rico on the day of the visit, how to identify the geographic north using stars as points of reference, how to present a real-time model of the solar system, how to identify zenith and ecliptic, and the outstanding characteristics of the planets in the Solar System.

Functional Redaction - This six hour workshop focused on providing participants assistance in improving their writing skills. During the first part of the workshop, thought activities such as reflection and binnacle, both skills that accompany the writing process, were used. In the second part of the workshop, the leader worked with individuals as they planned a text and produced a draft. In this way, the participants were immersed in the steps required to produce a good written text.

Conceptual Understanding - In this three hour workshop the origin of the TaDDEI Program and the aspects of the conceptualization module, such as the teacher's guide, the student guide and complimentary material were discussed and practice exercises were undertaken.

INTeGRE - This workshop presented the Institutional Module directed to construction of different chart types, data analysis, and descriptive statistics. Use of these modules enables participants to develop problem solving, analysis, and evaluation skills.

Internet: Pedagogic Tool in the Classroom – This workshop offered an introduction to the Internet, its services and their integration into the teaching-learning process and experiences of students.

AEL Workshop for students The workshop began with a group of eighteen 7-12 students engaging in a dynamic discussion of what issues a pilot must address when making a flight plan. Under the direction of workshop leaders students consider the design of the airplane, the amount of fuel, altitude, speed, terrain and weather conditions. Following the discussion, students use the provided data regarding the above aspects to work in pairs at nine stations designed to consider each aspect of the flight. The pre-discussion and work at the stations takes students about 50 minutes. Following their work at the stations, students share what they have learned through a round table discussion led by the workshop leaders. Following the discussion, each pair returns to its station, either to finish the activities that were in progress or to begin a new one. During that period, a workshop leader takes pairs of students through the flight simulation station where they can demonstrate their abilities in taking off and landing an airplane. Each student has approximately seven minutes to take off and land the airplane successfully. When they leave, students take with them the data they obtained and are required to use it to design a learning activity they share with classmates. Student and teacher evaluations of the experiences are sent to ISMuL for review and analysis as are copies of the activities students developed.

ISMuL's COLLEGE LEVEL ACHIEVEMENTS

Eighteen undergraduate students were involved in projects in biophysics, astronomy, meteorology, multimedia and computer applications, creation of curricular material, low-cost equipment and other teaching/learning aids design and construction. Eleven (11) of these 18 students were paid by NASA funds. This year one of our students presented a paper at a local meeting (ACS Junior Technical Meeting) on the topic of life on extreme environments, a first stage of a project that attempts to conduct a series of experiments to simulate planet Mars' environment, and the possibilities of life in that planet.

SATURDAY ACADEMIES

The purpose of the Saturday Academies is the training of pre-college teachers and students in energy-related topics and activities that they can take back to their classrooms. Teachers and students are selected in pairs to create an on-going relationship between teacher and student. Most of the students are from low-income families and environments that are lacking in science enrichment activities. Students and teachers are equal participants. They are provided with hands-on experiences that involve them in doing science. There is a focus on developing higher order thinking skills and depth of understanding through a process that takes them from the concrete to the conceptual level using a constructivist approach. Emphasis is placed on helping

them make connections between concepts in order to develop an integrated perspective of SEM. Energy/environment issues lend themselves to this approach. Cooperative learning is stressed in order to develop their capabilities as active self-learners. Thus, the teachers are exposed not only to new course content but also to new models of teaching and learning that they can use their classrooms.

A curriculum that centers on the topics of energy and environment was developed for this program. Also, a set of educational materials in Spanish was developed specifically for this purpose. Although some background information is included, the emphasis is on activities and principally on low-cost "experiments" that can be carried out with little or no laboratory equipment. This is supplemented by visits to local industries or facilities. For example, the group from San Juan visited an electricity generating plant in one of their field trips. An important part of the academy is the preparation of individual projects which are presented at the closing session. This activity places a value on the creativity and originality of the participants.

PRE-COLLEGE OUTREACH

This activity is directed to impacting the Puerto Rican student population as early as possible and maintaining their interest in energy-related issues throughout their school years. University research personnel (professors and students) visit public schools throughout the island to make presentations about their work. The 21 schools (7 from each level) were selected as target schools (by the SSI) for curriculum reform and other developmental programs. The main purpose of this activity is to present a positive image of the scientist as role-model, i.e., to transmit the idea that a life as a scientist is a possibility for them. Undergraduate and graduate student visits are particularly important in this regard. The visits consist of one-hour interactions with small groups (30 students) during which the scientist explains some aspect of his/her research interests preferably by carrying out a demonstration that he/she has prepared for the students. Researchers meet with HRD component personnel before each visit in order that they have a clear understanding of the goals and the philosophy behind this activity. Researchers are encouraged to discuss the reasons for their career choice, the importance of science to society and the opportunities for careers in science, engineering and related fields. The ideal visit is that in which the investigator engages in a lively conversation with students about their attitudes towards science and their career plans. An average of eight visits a year took place from 1997-2000.

Classrooms in both rural and urban settings were visited. In both cases the students reacted very positively to the visit from a "real" scientist whom they found to be much different from their preconceived ideas of who scientists are and what they do. Students' responses to questionnaires concerning the visits were used to guide preparations for visits for the next year.

The Science on Wheels Program is an attempt to remedy the fact that in Puerto Rico public schools have very limited access to science materials, scientific instrumentation or, in general, information about scientific careers. A professor at UPR-Mayaguez has developed a "science show" for students and a science training program for secondary teachers. A Science Education on Wheels mobile unit equipped with basic scientific instruments, interactive videos on science education, and micro scale science experiments provides students science demonstrations and

teachers training. This approach assists teachers in gaining new knowledge and insights and enhances the science experience of students.

The Science on Wheels project seeks the following objectives:

- Provide a cost effective program in chemistry reaching junior high school and early high school students-
- Motivate students to enroll in science classes and to participate more actively in science oriented programs.
- Provide the means to integrate student development in the area of chemistry with faculty development.
- Make available scientific equipment to junior high school and early high school students by providing hands on workshops and laboratory experience in the RUM-UPR facilities.
- Involve junior high school and early high school students and teachers in research in developing relevant demonstrations to be performed in their schools during the regular academic year. The focus will be on strengthening the presentation of chemistry and physics topics in ways that will be interesting and challenging and that will avoid common misconceptions often encountered in pre-college students.

4. Technical Accomplishments

High Energy Physics--The DOE-EPSCoR grant allowed the High Energy Physics Cluster to greatly increase its participation in experiments at the Fermi National Accelerator Laboratory. In this reporting period the cluster continued to make significant contributions to the acquisition and analysis of data from E831. The data run was highly successful, surpassing the goals in amount and quality. E831's data set (26000 Gb) will be the basis for measurements of charm quark physics of unprecedented precision. The cluster completed projects in the analysis of data from its detectors and continues to participate in the general analysis and data reduction. Another major project is the use of modern statistical methods in high energy physics. Additional high energy physics experiments funded by a DOE competitive grant award are underway, as is work on heavy quartz funded by a DOE-EPSCoR.

Novel Thin Film Materials for Optoelectronics Applications--Thin films of ferroelectric perovskites, layered structured oxides, relaxor materials and tungsten bronze type structures are important classes of materials for a variety of applications including non volatile memories, dynamic random access memories, infra-red sensors, actuators and optical waveguides. Lithium based oxide materials, on the other hand, are attractive for electrode materials, because they are capable of reversibly intercalating lithium-ions in a rechargeable battery without alerting the main unit. We have studied some of these novel materials, including lead based perovskites (PT, PLT, PLT:Ce, PLT:Gd, PZT, PZT:Nd), $\text{Ba}_x\text{Sr}_{1-x}\text{TiO}_3$ (BST), KTN, layered perovskites (SBT, $(\text{SBT})_x(\text{BTN})_{1-x}$, relaxors (PMT, PST, PZN, PMT-PT) tungsten bronze $\text{Sr}_{0.5}\text{Ba}_{0.5}\text{Nb}_2\text{O}_6$ (SBN) and BaMf_4 . Various growth techniques such as solution based route, sol-gel, pulsed laser deposition, rf-sputtering, conventional powder processing, and melt growth were used to prepare these materials in different forms. The effects of starting precursors and solution aging, A and B site doping, structural ordering on the ferroelectric and dielectric properties in these materials were studied. Micro-Raman technique has been very useful in identifying the phase, structural transformations and homogeneity at the submicron levels of these materials. Other important factors of device consideration, such as substrate, strain, disorder, and grain size effects, that greatly influence the lattice vibrational modes were also investigated. Results obtained by other characterization techniques such as XRD, SEM, AFM, and FTIR, were also used to understand the ferroelectric and dielectric properties of the synthesized materials.

The nonlinear optical properties of $\text{KNbO}_3/\text{KTaO}_3$ superlattice was characterized for the first time using ultrafast time-resolved degenerate-four-wave-mixing (DFWM) technique. The lattice structures grown by pulsed laser deposition consist of 8 layers with thicknesses of 40 nm (KTaO_3) and 30 nm (KNbO_3). Compared to the pure KTaO_3 substrate, the time-resolved spectrum of superlattice changes remarkably. A sharp coherent response signal is peaked at the time of zero delay of the probe pulse followed by a build-up of a longer-lived signal, showing an acceleration of the decay. This indicates that a significant contribution to the response signal comes from the KNbO_3 superlattice. With a total of about a 150 nm multiplayer thickness of KNbO_3 deposited on the KTaO_3 substrate, the third-order susceptibility $\chi^{(3)}$ was estimated to be dramatically increased by 2 orders of magnitude. Concurrently, the recovery process from the temporal lattice deformation driven by the laser excitation in the superlattice structure may occur in ns, i.e., much faster than in a poled bulk crystal.

Crack-free and transparent thin films and bulk glass samples were prepared by sol-gel method.

Nanoparticles of $\text{Eu}^{3+}:\text{Y}_2\text{O}_3$ have demonstrated an intensified luminescence and are very attractive for display devices. It was found that the lifetime of Eu doped in SiO_2 was much shorter. The shortening of the lifetime was ascribed to concentration quenching due to the limitation of solubility of Eu and formation of Eu clusters in SiO_2 glass. In 1% $\text{Eu}:\text{10}\%\text{Y}_2\text{O}_3:\text{SiO}_2$ glass it was found that the red luminescence was increased by a factor of 4 and the lifetime increased from 0.4 ms to 1.8 ms. It is believed that the Eu doped Y_2O_3 formed nanoparticles in SiO_2 glass. SiO_2 is an excellent optical matrix and $\text{Eu}:\text{Y}_2\text{O}_3$ may be of importance for display applications.

$\text{Mn}:\text{ZnS}$ is an important display material. It was found that the luminescence intensity of the material in form of nanocrystals was greatly increased. The UV irradiation-induced luminescence enhancement effect was assumed to be caused by UV induced new surface states which may increase the efficiency of the energy transfer from ZnS nanocrystals to the emission centers of Mn^{2+} .

The phosphorescent crystal fibers were successfully grown by the laser heated pedestal growth method for the first time. The new type of single crystals may find important applications in optoelectronic devices, for example, photoenergy storage devices. It also provides an opportunity to study phosphorescent dynamics on single crystals. We designed a pulse laser photostimulable phosphorescent experiment at far off-resonance condition and found that the excited Eu^{2+} ions that are responsible for emission of after-flow relaxed to the ground state three times faster than the decay of normal excited Eu ions. The fast relaxation time of the Eu ions is tentatively ascribed to the lattice distortion of the Eu sites that are storing photoenergy. In the measurement of thermoluminescence, it was found that the decay of the afterglow is the first order process and there are three types of trapping centers with different depths.

Dynamic light scattering was used to examine ferroelectric liquid crystalline phases in porous media. Whereas in larger pores (200nm) ferroelectric phases were observed, they were not found in the smallest pores (20nm). Additionally, the temperatures of several phase transitions were found to be suppressed in the pores relative to bulk. These observations have been explained by the structural aspects of antiferroelectric liquid crystalline materials in a confined geometry. We stress that cylindrical confinement exerts a strong influence on the appearance and dynamic properties of the ferroelectric phases. The results obtained can be summarized as follows: (i) The fast relaxation process is very prominent in the bulk sample but is partly suppressed in 200 nm pores and doesn't exist in 20 nm pores. (ii) The temperature of the phase transitions $\text{SmC}_A - \text{SmC}^*$ in 20 nm pores and $\text{SmC}_A - \text{SmC}(\text{gamma})$ in bulk and in 200 nm pores are of similar value, whereas (iii) the temperature of the $\text{SmC}^* - \text{SmC}_A$ phase transition in 200 nm pores is about 3 degrees lower and in 20 nm porous samples it is about 4 degrees lower than in the bulk sample, and (iv) the ferroelectric phases in AS573 exist in 200 nm pores as well as in bulk, but they are not formed in 20 nm pores on cooling from the isotropic phase.

Catalytic Processes for Energy Sources and Environmental Detoxification—The energy source project has contributed to the understanding of combustion and its by-products in the environment. New catalysts and materials, designed to enhance energy conversion and storage, are being studied to contribute to future technologies.

The environmental detoxification project has moved forward with new catalytic initiatives and new chemistry with organometallic compounds within this project. A major feature of this project is to develop a concerted program to implement and improve new solar photocatalytic detoxification technology to clean up environmental pollutants in exhaust streams and wastewaters. Moreover, our surface science component has dramatically enhanced the potential depth of this research with respect to the TiO_2 catalytic studies. The activities of the cluster have been both extensive and far-reaching considering its short time of existence. The cooperation and collaborations resulting from these projects has further enhanced the development of energy-related research in Puerto Rico. The DOE-EPSCoR initiative has also provided an opportunity to link energy-related research to student development.

Energy Sources--The development of new basic energy-related research initiatives in Puerto Rico was an important objective of the cluster. With this in mind, the state-of-the-art laser facilities at the University of Puerto Rico-Rio Piedras were fully utilized to study high-energy intermediates in the gas phase which are implicated in the combustion of fossil fuels. Thus, the photofragmentation of ClNO clusters and acetylene were generated to obtain a better understanding of the processes involved. The energy disposal processes were of major interest to these studies which include reactions in a van der Waal complex. The major challenge in these studies was to identify the chemistry which originates from the molecular clusters. Moreover, ground state oxygen atoms with sulfur-containing compounds were also studied. A new area received DOE support for the production of diamond films.

The photochemistry of luminescent metal complexes in layered materials was studied to develop systems which promote photoinduced charge separation. Among the project milestones were the synthesis and characterization of new layered zirconium phosphonates intercalated with a variety of luminescence probes. An octanuclear cluster, $\text{Fe}_8(\mu^4\text{-O})_4(\mu\text{-pz})_{12}\text{Cl}_4$, (1-Cl_4 ; pz = pyrazolato anion, $\text{C}_3\text{H}_3\text{N}_2^{1-}$) that consists of a Fe_4O_4 -cubane core encapsulated in a $(\text{Fepz}_3)_4$ shell out of which protrude tetrahedrally four chlorine atoms was constructed. This provided the basis for a new sub-project to contribute to the need for new porous materials with a variety of predetermined pore-sizes --- often dubbed Amolecular zeolites@ --- to be used for the separation of molecules based on size discrimination. New procedures were devised for the synthesis and a patent application submitted.

Environmental Detoxification Project--The new solid-liquid phase transfer catalyst work was extended to include a study of other potentially useful TIPS systems. TIPS hydrazine proved to be a particularly interesting new reagent for the preparation of unsymmetrical azines and as a useful protecting group. New initiatives on TIPS amino acid derivatives were initiated.

The bulk of the project concentrated on the development and implementation of Solar Photocatalytic Technology (SPT) for the destruction of hazardous wastes in Puerto Rico. Toward this end, the most advanced SPT available were applied to local conditions to address government, industry and the general population concerns for air, water and ground pollutants. New silica-titania catalysts that appear to be superior to the TiO_2 system itself were discovered and extensive studies were carried out mainly with toluene and tetrachloroethylene. This work was paralleled by new pilot plant studies. The invention and discovery of new catalytic materials

for energy-related processes and interests was another important objective of the research project. To better adapt the metal oxide photocatalytic oxidative detoxification to solar energy sources, the development of new adsorbed photosensitizers (*e.g.* phthalocyanines) provided an increase in the efficiencies of photochemical degradation of halogenated hydrocarbons in the visible range. The preparation of TiO_2 electrodes was also accomplished.

Ruthenium modified platinum surfaces have been treated with hydrogen, forming a complex $\text{Ru-RuO}_2\text{-RuO}_3/\text{Pt}$ surface that could be used as a catalyst for multiple applications, such as methanol oxidation. The average pore diameter (porosity), the nature of the surface (silica versus alumina), the surface coverage, the water content, and presence of oxygen are important factors in the photochemical transformations of polycyclic aromatic hydrocarbons (PAH) in the environment. The formation of PAH radical cation has been identified as the principal reactive intermediate. Charge transfer and /or singlet oxygen mechanisms appear to be operating in the photodegradation processes which lead to the photo-oxidation of the PAHs. These products could bind to vital biopolymers and be responsible for their mutagenic activity.

PUBLICATIONS

1997-2000

DOE Publications

Raman spectroscopic and nonlinear optical properties of barium nitrate crystal", P.G.Zverev, T.T.basiev, W.Jia and H.Liu, Proc.Advanced Solid-State Lasers, in OSA Trends in Optics and Photonics Series (TOPS), 1 (1996).

Up-conversion of multi-site Er in LiNbO₃ single crystal fibers", W.Jia, K.Lim, H.Liu, Y.Wang, J.J.Ju, S.I. Yun, F.E.Fernandez, W.W.Yen, J.Lumin., 66&67, 190 (1996).

Up-converted energy transfer from Er³⁺ to Cr³⁺ in LiNbO₃ single crystal fibers" W.Jia, K.Lim, H.Liu, Y.Wang, J.J.Ju, S.I.Yun, F.E.Fernandez, W.M.Yen, J.Lumin., 66&67, 228 (1996).

Host-dependent optical transitions of Er³⁺ ions in lead-germanate and lead-tellurium-germanate glasses", Z.Pan, S.H.Morgan, K.Dyer, A.Ueda and H.Liu, Jour.Appl.Phys., 79, 8906(1996).

Influence of the internal photo-induced electric field on the formation of self-pumped phase conjugation in doped (K_{0.5}Na_{0.5})_{0.2}(Sr_{0.75}Ba_{0.25})_{0.9}Nb₂O₆ crystals J.Zhang, H.Liu, W.Jia, Applied Optics, 35 6241(1996).

Degenerate-four-wave-mixing of nonether polyphenylquinoxaline solution, H.Liu, Y.Wang, W.Jia, SPIE Proc., 2853 48(1996).

Influence of the Internal Photoinduced Electric Field on the Formation of Self-Pumped Phase Conjugation in Doped (K_{0.5}Na_{0.5})_{0.2}(Sr_{0.75}Ba_{0.25})_{0.9}Nb₂O₆ Crystals", Jingwen Zhang, Huimin Liu, and Weiyi Jia, , Applied Optics, 35 6241 (1996).

Tantalum Oxide and Niobium Oxide Thin Films Grown by Pulsed Laser Deposition, F.E. Fernández and P.J. Marrero, Proceedings of the Materials Research Society, 397, 205 (1996).

Optical Spectroscopy of Pentavalent Chromium Ions in Glass, H. Yuan, W. Jia, D. Cohen, W.M. Yen and B.G. Aitken, Proceedings of Symposium of Glasses and Glass Formers, MRS 1996 Fall Meeting, Dec. 2 - 6, Boston.

Photon correlation spectroscopy of liquid crystals confined in porous matrices with different structure and pore size , F.M. Aliev and I. Plechakov, *Dynamics in Small Confining Systems III*, edited by J.M.Drake, J.Klafter, and R.Kopelman, *Materials Res. Soc. Symposium Proceedings*, 464, 177 (1997).

Broad band dielectric spectroscopy of liquid crystals confined in random and cylindrical pores, G.P. Sinha and F.M. Aliev, *Dynamics in Small Confining Systems III*, edited by J.M.Drake, J.Klafter, and R.Kopelman, *Materials Research Society Symposium Proceedings*, 464, 195 (1997).

Liquid crystalline behavior of octylcyanobiphenyl confined to submicron size randomly connected porous glasses, G.S. Iannacchione, S. Qian, D. Finotello, and F.M. Aliev, *Phys. Rev.*, E 56, 554, (1997).

Dielectric and optical properties of heterogeneous microcomposite materials based on porous matrices and liquid crystals , F.M. Aliev, *Proc. SPIE* 2949, 22 (1997).

Influence of confinement on dynamics of molecular motion and collective modes of liquid crystal dispersed in pores, F.M. Aliev and G.P. Sinha, *Molecular Crystals and Liquid Crystals*, 303, 325 (1997).

Dielectric relaxation of nematic liquid crystal confined in porous matrices, G.P. Sinha and F.M. Aliev, *Molecular Crystals and Liquid Crystals*, 303, N 4/5 (1997).

Heterogeneous nanocomposite materials based on liquid crystals and porous media , G.P. Sinha and F.M. Aliev, *Nanophase and Nanocomposite Materials II*, edited by S. Komarneni, J.C. Parker and H.J. Wollenberger, Materials Research Society Symposium Proceedings, 457, 431 (1997).

Slow dynamics and glass like behavior of liquid crystals dispersed in nanoporous media, F.M. Aliev and G.P. Sinha, , *Structure and dynamics of Glass and glass formers*, edited by C.A. Angel, K.L. Ngai, J. Kieffer, T. Egami, and G.U. Nienhaus, Materials Research Society Symposium Proceedings, 455, 273 (1997).

Excitation dynamics of cerium in niobate crystals, H.Liu, Y.Wang, W.Jia and F.Fernandez, *Jour. Alloys & Comp.*, 250 360(1997).

Formation of small polaron by two-photon excitation in niobate crystals" H.Liu, Y.Wang, W.Jia, *J.Lumin.*, 72-74, 945 (1997).

Dispersion effects of population grating in Cr-doped YAG crystal by four wave mixing" J.D.Romero, H.Liu and W.Jia, *J.Lumin.*, 72-74, 854(1997).

Validity using pump-probe pulses to determine the optical response of niobate crystals", H.Liu and W.Jia, *NASA URC-TC*, ed. M.Jamshidi et al, .Albuquerque., 1, 465, 1997.

Investigation into self-pumped and mutually-pumped phase conjugation with beams entering the negative C-face of doped $(K_{0.5}Na_{0.5})_{0.2}(Sr_{0.75}Ba_{0.25})_{0.9}Nb_2O_6$ crystals", J.Zhang, H.Liu, W.Jia, *Applied Optics*, 36 3753 (1997).

Irradiation induced luminescence enhancement effect of $ZnS:Mn^{2+}$ nanoparticles in polymer films", J.Yu, H.Liu, Y.Wang, F.E.Fernandez, W.Jia, *Opt.Lett.*, 22 913 (1997) .

Population Grating in Ca,Cr:YAG", J. D. Romero, H. Liu, Y. Wang and W. Jia, , *J. Lumin.*, 72-74, 854 (1997).

Formation of Small Polaron and Excitation Transfer in Niobate Crystals, Huimin Liu, Yanyun Wang and Weiyi Jia, *J. Lumin.*, 72-74, 945 (1997).

Irradiation-Induced Luminescence Enhancement of Mn doped ZnS Nanocrystals, J. Yu, H. Liu, W. Wang, F. Fernandez, W. Jia, et. al., *Optical letters*, 22 , 913 (1997).

Investigation into Self-Pumped and Mutually Pumped Phase Conjugation with Beams Entering the Negative c Face of Doped $(K_{0.5}Na_{0.5})_{0.2}(Sr_{0.75}Ba_{0.25})_{0.9}Nb_2O_6$ Crystals, Jingwen Zhang, Huimin Liu, and Weiyi Jia, *Applied Optics*, 36, 3753 (1997).

Excitation Dynamics of Cerium in Niobate Crystals", Huimin Liu, Yanyun Wang, Weiyi Jia, Felix Fernandez, *J. Alloys and Compounds*, 250, 360 (1997).

Influence of confinement on dynamics of molecular motion and collective modes of liquid crystal dispersed in pores, F.M. Aliev and G.P. Sinha, *Molecular Crystals and Liquid Crystals*, 303 , 325 (1997).

Liquid crystalline behavior of octylcyanobiphenyl confined to submicron size randomly connected porous glasses, G.S. Iannacchione, S. Qian, D. Finotello, and F.M. Aliev, *Phys. Rev.*, E 56, 554 (1997).

Optical rotatory power of a chiral liquid crystal in a confined geometry, D. Kang, C. Rosenblatt and F. Aliev, *Phys.Rev.Lett.*, 79, 4826 (1997).

Dielectric Behavior of Lead Magnesium Niobate Relaxors, Z. -Y. Cheng, R.S. Katiyar, X. Yao, and Aqiang Guo, *Physical Rev. B*55, 8165 (1997).

Investigation of Polarization mechanism of Relaxor Ferroelectrics, Zhong-Yang Cheng, S. Bauer, and R.S. Katiyar, *Materials Research Society Proceedings*, Edited by W.L. Warren et al., 453, 455 (1997).

Transition Dynamics in Ferroelectrics with Ordered Nanoregions, I.G. Siny, S.G. Lushnikov, and R.S. Katiyar, *Materials Research Society Proceedings*, Edited by S. Komarneni, 457, 39 (1997).

Characterization of $\text{SrBi}_2\text{Nb}_2\text{O}_9$ Thin Films prepared by Sol-gel Technique, E.Ching-Prado, W. Perez, A. Reynes-Figueroa, R.S. Katiyar, D. Ravichandran, and A.S. Bhalla, *Materials Research Society Proceedings*, Edited by E.P. George et al., 459, 213 (1997).

Morphotropic Phase Boundary in the Nanocrystalline $\text{PbZr}_x\text{Ti}_{1-x}\text{O}_3$ System, R.S. Katiyar, Jinfang Meng, *Materials Research Society Proceedings*, Edited by P.M. Fauchet et al., 452, 857 (1997).

A new probe to change Curie temperature of PbTiO_3 sensors, R.S. Katiyar and Meng Jinfang, *ACE Series on Aerospace Research and Education Partnership*, Vol 1 (1997).

Study of Phase transition and visible emission in nano-crystalline $\text{A}_{1-x}\text{A}_x'\text{TiO}_3$ System, J.F. Meng, Brajesh K. Rai, and R.S. Katiyar, *Phys. Lett. A* **229**, 254 (1997).

Luminescence spectra of Nanocrystalline $\text{Ba}_{1-x}\text{Pb}_x\text{TiO}_3$, R.S. Katiyar and Jinfang Meng, *Journal of Vacuum Science & Technology*.

Structural Characterization of $\text{SrBi}_2\text{Ta}_2\text{O}_9$ Thin Films, E Ching-Prado, W. Perez, A. Reynes-Figueroa, R.S. Katiyar, D. Ravichandran, and A.S. Bhalla, *Materials Research Society Proceedings*, Edited by Chang-Beom Eom et. al, 474, (1997).

Central Peak in Light Scattering from the relaxor ferroelectric $\text{PbMg}_{1/3}\text{Nb}_{2/3}\text{O}_3$, I. Siny, S.G. Lushnikov, R.S. Katiyar, and E.A. Rogacheva, *Physical Rev.* **B56**, 7962 (1997).

Photoluminescence Investigations in PMN-PIN ceramics, J.F. Meng, Brajesh K. Rai, Z.Y. Cheng, and R.S. Katiyar, and A.S. Bhalla, *J. Materials Research*.

Soft Mode Raman Spectroscopy of CsTiOAsO_4 Single Crystal, A.R. Guo, C.S. Tu, R.S. Katiyar, Ruyan Guo, and A.S. Bhalla, *Ferroelectrics Letters* **23**, 13 (1997).

Visible emission study in nanocrystalline $\text{Ba}_{1-x}\text{Pb}_x\text{TiO}_3$ and $\text{Sr}_{1-x}\text{Pb}_x\text{TiO}_3$ systems, J.F. Meng, Brajesh K. Rai, Ram S. Katiyar, and A.S. Bhalla, *Ferroelectrics Letters* **23**, 19 (1997).

Raman investigation on $(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$ System at Different Temperatures and Pressures, J.F. Meng, Brajesh K. Rai, R.S. Katiyar, and A.S. Bhalla, *J. Phys. Chem. Solids*, **58**, 1503 (1997).

Raman phonon modes and ferroelectric phase transitions in nanocrystalline lead zirconate titanate, J.F. Meng, R.S. Katiyar, and X.H. Wang, *Phys. Stat. Sol.* **A164**, 851 (1997).

Study of KTN Thin Films of Variable Composition Grown by Pulsed Laser Deposition, F.E. Fernández, M. Pumarol, P.J. Marrero, E. Rodríguez, and H.A. Mourad, *Proceedings of the Materials Research Society, Ferroelectric Thin Films VI*, 493, 365 (1998).

Raman Spectroscopy of Mg-Ta order-disorder in $\text{BaMg}_{1/3}\text{Nb}_{2/3}\text{O}_3$, I.G. Siny, R. Tao, R.S. Katiyar, R. Guo, and A.S. Bhalla, *J. Phys. & Chem. of Solids* **59**, 181 (1998).

Transition Dynamics in Relaxor Ferroelectrics, I. Siny and R.S. Katiyar, *Ferroelectrics Journal* **206 - 207**, 307 (1998).

Photoluminescence in $\text{PbMg}_{1/3}\text{Nb}_{2/3}\text{O}_3$ - $\text{PbIn}_{1/2}\text{Nb}_{1/2}\text{O}_3$ ceramics, J.F. Meng, Z.-Y. Cheng, Brajesh K. Rai, R.S.

Katiyar, E. Alberta, R. Guo, and A.S. Bhalla, *J. Materials Research* **13**, 1861 (1998).

Effect of doped ions on soft mode and phase transformations in Bi-Layered Compounds, Meng Jinfang R.S. Katiyar, and A.S. Bhalla, *Ferroelectrics Journal* **205**, 5 (1998).

Investigations of Ferroelectric Phase Transitions in Nanocrystalline $\text{Pb}_{1-x}\text{Ba}_x\text{TiO}_3$, R. S. Katiyar, Z.-Y. Cheng, and J. F. Meng, *J. Korean Phys. Soc.* **32**, S496 (1998).

Soft Mode in the Perovskite-layered Structure of $\text{PbBi}_2\text{Nb}_2\text{O}_9$, S.G. Lushnikov, I.G. Siny, A.A. Savvinov, R.S. Katiyar and V.V. Bakhurin, *J. Korean Phys. Soc.* **32**, S534 (1998).

Anomalies in the Raman Spectra of KNSBN with the Tungsten-bronze Structure, A.A.Savvinov, I.G. Siny, R.S. Katiyar, and H.-C. Chen, *J. Korean Phys. Soc.* **32**, S617 (1998).

A Model to Simulate Complex Dielectric Permittivity of Relaxor Ferroelectrics, Z.-Y. Cheng, J.F. Meng, and R.S. Katiyar, *J. Korean Phys. Soc.* **32**, S947 (1998).

Thermally Stimulated Depolarization Current of a Nonlinear Optical Side Chain Polymer, Z.-Y. Cheng, R. S. Katiyar, S. Bauer and S. Bauer-Gogonea, *J. Korean Phys. Soc.* **32**, S221 (1998).

Dielectric Spectrum and its Relationship with Time for PLZT 8/65/35 Ceramic under DC Bias, Z.-Y. Cheng, R. S. Katiyar and X. Yao, *J. Korean Phys. Soc.* **32**, S1042 (1998).

Optical Properties of RbTiOAsO_4 single crystal, C.S. Tu, Y.L. Yeh, R.S. Katiyar, R. Guo, V.H. Schmidt, R.-M. Chien, Ruyan Guo, and A.S. Bhalla, *J. Korean Phys. Soc.* **32**, S472 (1998).

Raman and Photoluminescence spectroscopy of nano-crystalline PbTiO_3 sensor materials with different doping ions, R.S. Katiyar and J.F. Meng, *NASA URC Technical Advances in Aeronautics, Space Sciences and Technology, Earth Systems Sciences, Global Hydrology, and Education*, Edited by T.L. Coleman, B. White, and S. Goodman, **III**, 763 (1998).

Temperature dependence of the dielectric constant of relaxor ferroelectrics, Z. Y. Cheng, R.S. Katiyar, and A.S. Bhalla, *Phys. Rev.* **B57**, 8166 (1998).

Investigations on KTN thin films by micro-Raman spectroscopy, A.A. Savvinov, I.G. Siny, and R.S. Katiyar, *XVIIth International Conference on Raman Spectroscopy* (edited by A. M. Heyns John Wiley & Sons, 1998) pp 828.

Light scattering and phase transition dynamics in PMN, I.G. Siny and R.S. Katiyar, *Ferroelectrics Journal* **0**.

Dielectric behavior of quenching PLZT 7/70/30 ceramics, Z.-Y Cheng, A. Guo, X. Yao, and R.S. Katiyar, *Journal of IEEE Proceedings*.

Photoluminescence studies in $\text{Pb}_{1-x}\text{Ba}_x\text{TiO}_3$ ceramics, J.F. Meng, R.S. Katiyar, and Zou Guangtian, *Ferroelectrics Letters*.

Grain Size Effects on Ferroelectric phase transitions in $\text{Pb}_{1-x}\text{Ba}_x\text{TiO}_3$ System, J.F. Meng, R.S. Katiyar, and G.T. Zou, *J. Phys. Chem. Solids*.

A thickness dependent study of $\text{SrBi}_2\text{Nb}_2\text{O}_9$ thin films, W. Perez, E. Ching-Prado, A. Reynes-Figueroa, R.S. Katiyar, D. Ravichandran, and A.S. Bhalla, *Materials Research Society Proceedings*, Edited by R.E. Treece et al., **493**, 237 (1998).

Contribution to the dielectric behavior of relaxors from the surface of nano-order cluster in the materials, Z.-Y. Cheng and R.S. Katiyar, *Materials Research Society Proceedings*, Edited by S.R. Phillpot et al., **492**, 337 (1998).

High pressure Raman scattering study in nano-crystalline ABO_3 oxides, R.S. Katiyar, J.F. Meng, *Materials Research Society Proceedings*, Edited by R.M. Wentzcovitch et al., 499, ().

Dielectric properties and glassy behavior in Some solid Solution ceramics: $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - PbTiO_3 - BaTiO_3 , Z. - Y. Cheng, R.S. Katiyar, X. Yao, and X. Wang, *Phil. Mag. B* (Accepted).

Cation arrangement in the complex perovskites and vibrational spectra, Igor Siny, R.S. Katiyar, and A.S. Bhalla, *J. Raman Spectroscopy* 29, 385 (1998).

Growth and micro-Raman study of pulse laser deposited KTN Thin Films, Alexy Savvinov, Igor Siny, Ram Katiyar, Manuel Pumarol, Houssam Abou Murad, and Felix Fernandez, *Materials Research Society Proceedings* 526, (1998).

Dielectric behavior and phonon damping in low-dielectric constant perovskite materials, Igor Siny, Ram Katiyar, Ruyan Guo, and Amar Bhalla, *Materials Research Society Proceedings* 511, (1998).

$\text{PbMg}_{1/3}\text{Nb}_{2/3}\text{O}_3$ as a model for light scattering experiments, I.G. Siny, S.G. Lushnikov, R.S. Katiyar, and V.H. Schmidt, *Ferroelectrics Journal*.

Low Frequency phonon modes and ferroelectric phase transitions in nano-crystalline $\text{Pb}_{1-x}\text{A}_x\text{Ti}_{1-y}\text{B}_y\text{O}_3$ System, R.S. Katiyar and J.F. Meng, *J. Ferroelectrics*.

Raman and infrared study of $\text{Ba}_{1-x}\text{Sr}_x\text{TiO}_3$ Thin films grown by pulsed laser deposition, W. Perez, R.S. Katiyar, E. Ching-Prado, L.A. Knauss, and J.S. Horwitz, *Asian J. Physics*.

Micro-Raman Investigations of Pressure Induced Transformations in MBBA, J.F. Meng, G.P. Sinha, P.S. Dobal, and R.S. Katiyar, *J. Raman Spectroscopy*.

Hypersonic anomalies and optical properties of RbTiOAsO_4 and KTiOPO_4 Single Crystals, Chi-Shun Tu, R.S. Katiyar, V. Hugo Schmidt, Ruyan Guo, and A.S. Bhalla, *Phys. Rev. B*.

The Appearance of Ferrielectric phases in a confined liquid crystal investigated by photon correlation spectroscopy, Yu. Panarin, C. Rosenblatt and F.M. Aliev, *Phys. Rev. Lett.*, 81, 2699, (1998).

Dielectric spectroscopy of liquid crystals in smectic, nematic and isotropic phases confined in random porous media, G.P. Sinha and F.M. Aliev, *Phys. Rev.*, E 58, 2001 (1998).

The Appearance of Ferrielectric phases in a confined liquid crystal investigated by photon correlation spectroscopy, Yu. Panarin, F.M. Aliev and C. Rosenblatt, *Molecular Crystals and Liquid Crystals*.

Dynamics of molecular motion of Nematic crystal confined in cylindrical pores, B. Batalla, G.P. Sinha and F.M. Aliev, *Molecular Crystals and Liquid Crystals*.

Surface and Size Effects on the Ferroelectric Phase Transition and Surface Polarization of Ferroelectric Thin Films: Monte Carlo Simulations, J. Romero and L.F. Fonseca, *Mat. Res. Soc. Symp. Proc.*, 493, 99 (1998).

Photoluminescence and fast nonlinear optical response of barium titanate crystals, H.Liu, W.Jia, *J.Lumin.*, 76/77 100 (1998).

Phosphorescent Dynamics in $\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}$, Dy^{3+} Single Crystal Fibers, W.Jia, H.Yuan, L.Lu, H.Liu, W.M.Yen, *J.Lumin.*, 76/77 424 (1998).

Luminescence spectrum of divalent europium ions doped in SrAl_4O_7 , W.Jia, H.Liu, H.Yuan, L.Lu and W.M.Yen,

Electrochemical Society Proc., 97-27 368 (1998).

Photoluminescence of trivalent europium ions doped in CaAl_2O_7 , H.Yuan, W.M. Dennis, L.Lu, W.M.Yen, W.Jia, and H.Liu, Electrochemical Society Proc., 97-27, 206 (1998).

Optical properties of ZnS:Mn^{2+} nanoparticles in polymer films, J.Yu, H.Liu, Y.Wang, F.Fernandez and W. Jia, J. Lumin., 76/77, 100 1998.

A new analysis method to characterize the S-band luminescence decay of porous Si, J.Yu, H.Liu, Y.Wang, W.Jia, L.F. Fonseca, S.Z. Weisz and O Resto, J.Lumin.

Hot luminescence of Mn^{2+} in ZnS nanocrystals, J.Yu, H.Liu, Y.Wang, W.Jia, J. Lumin.

A model of transient optical response of $\text{KTa}_{1-x}\text{Nb}_x\text{O}_3$ crystals: the role of charge transfer vibronic excitons, V. Vikhnin, H.Liu, W.Jia, J.Phys.Cond.Matt.

SBN thin film growth by pulsed laser deposition and characterization of nonlinear optical properties, F.Fernandez, H. Liu, C. Jing, Y.Fu and W. Jia, *Mat. Res. Soc. symp. Proc.*, April 1998.

Photoluminescence of $\text{Eu}^{3+}:\text{Y}_2\text{O}_3$ nanoparticles embedded in SiO_2 glass, W. Jia, Y. Wang, M. Santiago, L. Castero and H. Liu, *Mat. Res. Soc. symp. Proc.*, April 1998.

Transient grating in a $\text{KNbO}_3/\text{KTaO}_3$ superlattice, H.Liu, F. Fernandez, W.Jia, L.A. Boatner, SPIE Proc., 1998

Modulation of the nonlinear optical response by KNbO_3 thin films deposited on a KTaO_3 substrate, H. Liu*, W. Jia, F.Fernandez, L.A. Boatner, *Inter.Conf.Appl.Photo., Ottawa, Canada, July, 1998.*

Photoluminescence of Eu^{3+} Doped Sol-Gel SiO_2 Thin Films and Glass, Lymari Castro, W. Jia, Y. Wang, Miguel Santiago, H. Liu, *Proceedings of NASA-URC Conference, III*, (edited by. T.L. Coleman, B. White and S. Goodman) 638, 1998.

Hot Luminescence of Mn:ZnS nanocrystal in polymer thin films, Jiaqi Yu, Huimin Liu, Yanyun wang and Weiye Jia, J. Lumin.

Growth and Characterization of $\text{Eu,Dy:SrAl}_2\text{O}_4$ and $\text{Eu,Nd:CaAl}_2\text{O}_4$ Single Crystal Fibers, W. Jia, H. Yuan, L. Lu, H. Liu and Willian Yen, J. Crystal Growth.

Structure and Properties of III-N Semiconductor Thin Films Grown by N-Radical-Assisted PLD F.E. Fernández, M. Pumarol, A. Martínez, V. Pantojas, and M. García, *Proceedings of the Materials Research Society, Nitride Semiconductors*, 482 337 (1998).

The influence of the substrate temperature on the recombination processes in a-Si:H, Y. Lubianiker, I. Balberg, L.F. Fonseca, and S.Z. Weisz, *Mat. Res. Soc. Symp. Proc.* (1997).

Sensitization of the Minority Carrier Lifetime in a-Si:H, R. Rapaport, Y. Lubianiker, I. Balberg, and L.F. Fonseca. *Appl. Phys. Lett.* 72, 103 (1998).

Luminescence of Eu^{3+} doped SiO_2 thin films and glass prepared by sol-gel technology, L.Castro, W.Jia, Y.Wang, M. Santiago and H.Liu, *NASA URC-TC*, (Edited by T.L. Coleman et al., TSI Press, Huntsville, AL.) 3, 634 (1998).

Fluorescence of pentavalent chromium in SiO_2 Sol-Gel glasses, W.Jia, L.Castro, Y.Wang and H.Liu, *NASA URC-TC*, (Edited by T.L. Coleman et al., TSI Press, Huntsville,) 3, 639 (1998).

Anisotropically coherent optical-response of Eu- doped yttrium orthosilicate, H.Liu, Y.Wang, M. Santiago and W.Jia, *NASA URC-TC*, (Edited by T.L. Coleman et al., TSI Press, Huntsville,) 3, 848 (1998).

Photoluminescence of Trivalent Europium Ions Doped in CaAl_2O_7 , H. Yuan, W.M. Dennis, L. Lu, W.M. Yen, W. Jia and H. Liu, *Electrochemical Society Proceedings*, 97-29, 206 (1998).

Luminescence Spectra of Divalent Europium Ions Doped in SrAl_2O_7 , W. Jia, H. Liu, H. Yuan, Li Lu, and W.M. Yen, *Electrochemical Society Proceedings*, 97-29, 368 (1998).

Fluorescence of Pentavalent Chromium Doped in Sol-Gel SiO_2 Glass, W. Jia, Lymari Castro, Y. Wang and H. Liu, *Proceedings of NASA-URC Conference, III*, (Edited by T.L. Coleman et al., TSI Press, Huntsville,) 639 (1998).

Long Persistent Photoconductivity of Single Crystal of $\text{SrAl}_2\text{O}_4:\text{Eu}^{2+}, \text{Dy}^{3+}$ phosphors, H. Yuan, W. Jia, S. Basun, U. Happek, J. Choi, L. Lu, R.S. Meltzer and W.M. Yen, SID, SPIE.

Photoluminescence and Fast Nonlinear Optical response of Barium Titanate Crystals, Huimin Liu and Weiyi Jia, *J. Lumin.*, 76 & 77, 100 (1998).

C.E. Feliciano and E. Quiñones, "The Association Between the Excited States of 4-(N,N Dimethylamino)benzonitrile and β -cyclodextrin in Dimethyl Sulfoxide and in N,N-dimethylformamide" J. Photochem. Photobiol. A: Chem. 1999, 120, 23-28.

C. Conde, C. Maul and E. Quiñones, "State-Resolved Photofragmentation of $[\text{ClNO}]_n$ van der Waals Clusters in a Supersonic Jet" J. Phys. Chem. A. 1999, 103, 1929-1938.

V.I. Makarov, and E. Quiñones, "Relaxation of Individual Rotational States of the $\tilde{A}^1A_u$ Electronic State of Acetylene Excited to the $2\nu_3'$ and $(\nu_1' + \nu_3' + \nu_6')$ Vibrational Modes" Chem. Phys. 2000, 253, 259-265.

V.I. Makarov, and E. Quiñones, "Photobleaching of the SO_2 $\text{C}^1\text{B}_2 \rightarrow \text{X}^1\text{A}_1$ Transition Optically Pumping the $\tilde{a}^3\text{B}_1$ State" J. Photochem. Photobiol. A: Chem.

In-situ Spectroscopic Ellipsometry Study of the Oxide Etching and Surface Damaging Processes on Silicon Carbide and Silicon under Hydrogen Plasma, Morell, G.; Vargas, I.M.; Manso, J.Y.; Guzman, J.R.; Weiner, B.R.; Martinez, A. Materials Research Society Symposium Proceedings Vol. 591, 2000, pp. 295-300.

Controlling the Diamond Film Morphology and Intrinsic Stress By Low-Energy Electron Bombardment, Morell, G.; Gonzalez, J.A.; Figueroa, O.L.; Weiner, B.R. Materials Research Society Symposium Proceedings Vol. 585, 2000.

In Situ Spectroscopic Ellipsometry Study of the Diamond Nucleation and Film Evolution Processes, Morell, G.; Figueroa, O.L.; Cancel, L.M.; Weiner, B.R. Materials Research Society Symposium Proceedings Vol. 580, 2000.

G2 Theoretical and Direct Ab Initio Molecular Dynamics Study of the Reaction of $\text{O}(\tilde{P})$ with Thirane, $\text{O}(\tilde{P}) + \text{C}_2\text{H}_4\text{S}(\tilde{A}_1) \rightarrow \text{SO}(\tilde{\Sigma}) + \text{C}_2\text{H}_4(\tilde{A}_g)$, Ishikawa, Y.; Gong, Y.; Weiner, B.R., *Phys. Chem. Chem. Phys.*, 2000, 2, 869.

In situ Measurements of Methane and Acetylene Concentrations in a CVD reactor by Infrared Spectroscopy, Morell, G.; Canales, E.; Weiner, B.R. *Diamond and Diamond Related Materials*, 1999, 8, 166-170.

Hydrothermal Synthesis of a Novel Three-Dimensional Coordination Polymer $[\text{Cd}_2(4,4'\text{-bipy})_2(\text{H}_2\text{O})_3(\text{SO}_4)_2]\cdot\text{H}_2\text{O}$ with Nonlinear Optical Properties, Huang, S.D.; Xiong, R.-G.; Han, J.; Weiner, B.R. *Inorganica Chimica Acta*, 1999, 294, 5-9.

Measurement and Analysis of Diamond Raman Bandwidths, Morell, G.; Quiñones, O.; Diaz, Y.; Vargas, I.M.; Weiner, B.R.; Katiyar, R.S. *Diamond and Diamond Related Materials*, 1998, 7, 1029.

On-site Characterization of Electrocrystallized Platinum Particles on Carbon and Sol-gel Thin Film Modified Carbon Surfaces, Guo, Y.; Guadalupe A.R., *Langmuir* 1998.

Aerogel from Metastable Lamellar Surfactant/Sol-gel Composite, Guo, Y.; Guadalupe, A.R., *Chem. Comm.*, 1998.

Electroanalytical Applications of Screen-Printable Surfactant-Induced Sol-Gel Graphite Composites, Guo, Y. and Guadalupe, A.R., *Sensors and Actuators, Chemical Part B-Chemical*, 46(3), 213, 1998.

Preconcentration and Voltammetry of Mercury on a Functionalized Sol-Gel Thin Film Modified Glassy Carbon Electrode, Guo, Y.; Guadalupe A.R., *J. Pharm. Biomed. Anal.*, 1998.

Chemically-Derived Prussian Blue Sol-gel Composite Thin Films, Guo, Y.; Guadalupe, A.R., *Chemistry of Materials*, 1998.

Hexaisopropylsilane, Antomattei, A.; Soderquist, J. A.; Huang, S. D. Z. *Kristallogr. NCS*, 1999, 214, 43.

Unsymmetrical Azines via Triisopropylsilylhydrazine, Justo de Pomar, J. C.; Soderquist, J. A., *Tetrahedron Lett.*, 2000, 41, 3285.

A Versatile Synthesis of 9-BBN Derivatives from Organometallic Reagents and 9-(Triisopropylsilyl)thio-9-borabicyclo[3.3.1]nonane, Soderquist, J. A.; Justo de Pomar, J. C. *Tetrahedron Lett.*, 2000, 41, 3537.

Triisopropylsilylhydrazine: A Versatile Reagent for Carbonyl Protection in Aldehydes and Ketones, Justo de Pomar, J. C.; Santiago-Salinas, M.; Rivera-Sostre, D.; Soderquist, J. A.; *Tetrahedron Lett.*, 2000, 41, XXXX.

NON-DOE Publications

Degenerate-four-wave-mixing of C₆₀ doped glass, H.Liu, B.Taheri, W.Jia, *Appl.Phys.Lett.* 8, 1570 (1996).
Optical properties of fullerene in glass, H.Liu, Y.Wang, W.Jia, F.Lin and S.Mao, *Nonlinear Opt.* 15, 459 (1996).

Degenerate-four-wave-mixing of C₆₀ doped glass, H.Liu, B.Taheri, W.Jia, *Appl.Phys.Lett.* 68 1570 (1996).

Intensity scan and two photon absorption and nonlinear refraction of C₆₀ in toluene, B.Taheri, H.Liu, B.Jassemnejad, D.Appling, R.C.Powell and J.J.Song, *Appl.Phys.Lett.* 68, 1317 (1996).

Picoseconds pulse induced NLO response of fullerene glass, H.Liu, W.Jia, F.Lin and S.Mao, *J.Lumin.*, 66&67, 128 (1996).

Polarization Effects in AlGaAs Single crystal quantum well laser structure, P.S. Dobal, H.D. Bist, A. Mannivanam, R.S. Katiyar, S.K. Mehta, and R.K. Jain, *Solid State Comm.* 100, 337 (1996).

High Pressure Raman Spectroscopy of Stoichiometric Ferroelectric Potassium Lithium Niobate, M.J. Massey, R.S. Katiyar, B.M. Jin, and A.S. Bhalla, *Ferroelectrics Journal*, 189, 189 (1996).

Formation of Small Polaron and Niobate Crystals, Huimin Liu, Yanyun Wang and Weiyi Jia, *J. Lumin.*, 72-74, 945 (1997).

Comments on Dielectric properties of Ba_{1-x}Sr_xTiO₃ ceramics, Z. -Y. Cheng and R.S. Katiyar, *J. Phys.* D30, 1165 (1997).

Raman Scattering Study of Thermally Reduced Stabilized Cubic Zirconia, G. Morell, R.S. Katiyar, D.I. Torres, S.E. Paje, and J. Llopis, *J. Applied Physics* 81, 2830 (1997).

Effect of defects on Dielectric Properties in KTiOAsO₄, KTiOAsO₄, KTiOAsO₄ Single Crystals, A.R. Guo, Zhong-Yang Cheng, Ruyan Guo, A. Bhalla, and R.S. Katiyar, *Materials Research Society Proceedings*, Edited by A. Jacobson et al., 453, 507 (1997).

Investigation of Dipolar Relaxation in a Side-Chain Non-linear Optical Polymer Film, Zhong-Yang Cheng, S. Bauer, and R.S. Katiyar, *Materials Research Society Proceedings*, Edited by W.L. Warren et al., 446, 97 (1997).

Investigations on nanocrystalline thin films of CdSe for potential sensor device applications, Brajesh K. Rai, R.S. Katiyar, M.T.S. Nair, P.K. Nair, and A. Manivannam, *ACE Series on Aerospace Research and Education Partnership*, Vol 1 (1997).

Raman scattering study of H₂O₂ - etched Surface of Zn_{0.1}Cd_{0.9}Te, Brajesh K. Rai, K.-T. Chen, H. Chen, Arnold Burger, and R.S. Katiyar, *Materials Research Society Proceedings*, Edited by M.O. Manasreh et al., 450, 287 (1997).

Simultaneous Observation of Strong and Weak Quantum confinement effect in chemically deposited CdSe thin films: A spectro-structural study, Brajesh K. Rai, H.D. Bist, R.S. Katiyar, M.T.S. Nair, P.K. Nair, A. Mannivanam, *J. Applied Physics* 82, 1 (1997).

Spectroscopic Study of CaSZ and YSZ Thermochemically Reduced Crystals, D.I. Torres, S.E. Paje, J. Llopis, G. Morell, and R.S. Katiyar, *Journal of Luminiscence*, 72-74, 724 (1997).

Lattice Dynamics of Crystals having R_2MX_6 Structure, D.I. Torres, J.D. Freire, and R.S. Katiyar, *Physical Rev.* B56, 7763 (1997).

Micro-Raman scattering of bismuth titanate at low temperatures, J.F. Meng and R.S. Katiyar, *J. Raman Spectroscopy* 28, (1997).

Hypersonic Study of $CsTiOAsO_4$ and $KTiOAsO_4$ Single Crystals, Chi-Shun Tu, V. Hugo Schmidt, R.M. Chien, R.S. Katiyar, Ruqian Guo, Ruyan Guo, and A.S. Bhalla, *Physical Rev.* B56, (1997).

Measurement and Analysis of diamond Raman bandwidths, G. Morell, O. Quinones, Y. Diaz, I.M. Vargas, B.R. Weiner, and R.S. Katiyar, *Proc. of the 8th European Conference on Diamond, Diamond-like and related Materials*, 7, 1029 (1997).

Characterization of GaAs Wire Crystals Grown in Porous Si, S.W. da Silva, D.I. Lubyshev, P. Basmaji, Yu.A. Pusep, P.S. Pizani, J.C. Galzerani, R.S. Katiyar, and G. Morell, *J. Appl. Phys.* 82, 6247 (1997).

Thermally Stimulated Depolarization Current of a Nonlinear Optical Side Chain Polymer, Z.-Y. Cheng, R. S. Katiyar, S. Bauer and S. Bauer-Gogonea, *J. Korean Phys. Soc.* 32, S221 (1998).

Investigations of the effects of low temperatures and pressures of ECR diamond films by Raman spectroscopy, S. Gupta, G. Morell, R.S. Katiyar, D.R. Gilbert, and R.K. Singh, *XVth International Conference on Raman Spectroscopy* (edited By A. M. Heyns John Wiley & Sons, 1998) pp 498.

Localized vibrations of Cr in ZnSe, S. Bhaskar, P.S. Dobal, B.K. Rai, R.S. Katiyar, and A. Burger, *XVth International Conference on Raman Spectroscopy* (edited By A. M. Heyns John Wiley & Sons, 1998) pp 626.

Optical Phonon modes and phase transition in $Bi_4Ge_{3-x}Ti_xO_{12}$ ceramic system, J.F. Meng, P. S. DoBal and R.S. Katiyar, *J. Raman Spectroscopy*.

Raman and Photoluminescence studies on intrinsic and Cr-Doped ZnSe single crystals, Brajesh K. Rai, R.S. Katiyar, K.-T. Chen, and A. Burger, *Materials Research Society Proceedings*, Edited by S. Sivanathan et al., 484.

Photoluminescence study of deep levels in Cr-doped ZnSe, S. Bhaskar, P. S. DoBal, B. K. Rai, R. S. Katiyar, H. D. Bist, J.-O. Napp and A. Burger, *J. Appl. Phys.* 85, 0000 (1999).

Optical properties and nanoparticle size distribution in luminescent porous silicon, L.F. Fonseca, O. Resto, R.S. Katiyar, Sanju Gupta, S.Z. Weisz, Y. Goldstein, A. Many, and J. Shappir, *Proceedings of 24th International Conference on Physics of Semiconductors*.

Study of diamond films grown at low temperatures and pressures by ECR-assisted CVD, S. Gupta, G. Morell, R.S. Katiyar, D.R. Gilbert, and R.K. Singh, *Proceedings of 9th European Conference on Diamond, Diamond-like, Nitrides and Silicon carbide*.

Micro-Raman Investigations of Pressure Induced Transformations in MBBA, J.F. Meng, G.P. Sinha, P.S. Dobal, and R.S. Katiyar, *J. Raman Spectroscopy*.

Cobalt Polypyridyl Complexes as Redox Mediators for Lipoamide Dehydrogenase, Colón, C.; Guadalupe, A.R., *Electroanalysis*, 10(9), 621, 1998.

Reusable Doped Sol-gel Graphite Electrodes for Metals Ions Determination, Zhiqin J.; Guadalupe A.R. *Electroanalysis*, 1998.

Silacycles as Templates for Acyclic Diastereoselection, Soderquist, J. A.; Negron, A. *Tetrahedron Lett.*, 1998, 39, 9397.

Novel Silyl-Mediated 10-TMS-9-BBD Organoborane Reagents for Asymmetric Synthesis, Soderquist, J. A.; Matos, K.; Burgos, C. H.; Lai, C.; Vaquer, J.; Medina, J. R. in *Contemporary Boron Chemistry*, Royal Society of Chemistry: Cambridge, UK.

AResonance Raman Studies of the Heme-Ligand Active Site of Hemoglobin I from Lucina pectinata@. J. Cerda, J. Lopez-Garriga. *Biospectroscopy* 1999, 5, 289-301.

ANatrinema thermotolerans sp. nov., a halophilic archaeon from Puerto Rico@A. Oren, J. Lopez-Garriga, R. Montalvo, R. H. Vreeland, A. Ventosa, M. Kamekura, *Inter. J. Syst. Bacteriol.* 1999.

The cDNA-Derived Amino Acid sequence of Hbl from Lucina pectinata. F.M. Antommattei, T. Rosado-Ruiz, C.L. Cadilla, J. López-Garriga. *J. Protein. Chem.* 2000.

R.C. Binning, Jr., M.-S. Liao, C.R. Cabrera, Y. Ishikawa, H. Iddir, R. Liu, E.S. Smotkin, A.J. Aldykiewicz, and D.J. Myers,@Density Functional Calculations on CO Attached to PtnRu(10-n) (n=6-10) Clusters@, *International Journal of Quantum Chemistry* 2000.

D. Blasini, R. Castro, C. Cabrera, N. Batina, and I. González, AStudy of The (3-Mercaptopropyl)trimethoxysilane Self-Assembly on Iodine Coated Gold Electrodes@ Proceedings of the International Symposium on New Directions in Electroanalytical Chemistry II, Electrochemical Society Proceedings, 1999, 247.

M.-S. Liao, C.R. Cabrera, and Y. Ishikawa, AA theoretical study of CO adsorption on Pt, Ru and Pt-M (M= Ru, Sn, Ge) clusters@, *Surface Science* 2000, 445, 267.