Proposal Information
Proposal Number       0348795
Proposal Title    CAREER: Near-field Imaging of materials dynamics processes at nanometer resolution
Received on     07/23/03
Principal Investigator    Andres La Rosa
Institution Portland State University

This Proposal has been Electronically Signed by the Authorized Organizational Representative (AOR).

Program Information
NSF Division      Electronics, Photonics, & Device Technol
Program Name    ELECT, PHOTONICS, & DEVICE TEC
Program Officer  Venkata Rao Mulpuri
Telephone           (703) 292-0000
E-Mail                vmulpuri@nsf.gov

Review Information
External Peer Review began on   10/30/03

Proposal Status
Status As of Today Dated: 01/14/04
This proposal has been declined by NSF.

Your proposal to the CAREER FY 2004 competition has been received by the National Science Foundation (NSF), and was assigned to the program that you requested upon submission. If necessary, proposals may be reassigned to other NSF programs. Information on any changes in the program assignment of your proposal, the date of final program approval, as well as the identification of overdue reports and other factors that might be delaying the proposal process, will be available on this page and should enable you to track the progress of your proposal.

Deadline for submission of CAREER proposals is July 22, 23, or 24, 2003, depending on the Directorate/Office to which you submitted your proposal. Administrative review of proposals for completeness and conformance to NSF guidelines, as well as appropriate program assignment, is carried out in the weeks immediately following these submission deadlines. Proposals that do not meet required guidelines will be returned without review.

All compliant CAREER proposals will be evaluated by external peer review. Please note that the review process and specific dates of proposal processing may vary from program to program within this general timeframe. The Program Officer to whom your proposal
has been assigned is your best source of detailed information on the processing of your proposal and will assist you with any additional information that you require.

NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months of the submission deadline. Notification of the nature of final actions on CAREER proposals will be made electronically to the institution's sponsored projects office in the case of awards, and to applicants in the case of declinations.


Reviews
All of the reviews of your proposal that have been released to you by your NSF program officer can viewed below.
Please note that the Sponsored Research Office (or equivalent) at your organization is NOT given the capability to view your reviews.

Context Statement

**Context:**
This proposal was submitted for the CREER program in the Electronics, Photonics and Device Technologies (EPDT) Program of the Electrical and Communications Systems (ECS) Division. Proposals submitted to the EPDT Program were divided into four panels by subject areas. This proposal was placed in the panel on nano-, organic- and compound semiconductor electronics, which was held on October 30-31, 2003. This panel contained 22 proposals that were reviewed by 12 experts. The panelists had reviewed the proposals in their areas of expertise prior to coming to the panel meeting. At least four panelists provided written evaluations for each proposal. The written evaluations were presented to the panelists who debated the strengths and weaknesses of the proposals that were then assigned preliminary ratings. The panel discussions concerning the proposals were documented by a panel Scriber, who read aloud the summary of the discussion to the panel for unanimous approval. After all the proposals had been reviewed and rated, the panel placed the proposals into three categories: (i) Highly Recommended [HR], (ii) Recommended [R] and (iii) Do Not Recommend [DNR] for funding. Proposals were reviewed and evaluated against both merit review criteria established by the National Science Board. These were "What is the intellectual merit of the proposed activity?" and "What are the broader impacts of the proposed activity?" The reviewers also gave careful consideration to the elements relating to the Integration of Research and Education, and Integration of Diversity into NSF Programs, Projects, and Activities in making their recommendations. The panel also tried to provide constructive feedback when it was felt that a more fully developed research plan, greater creativity or broader scope would make the proposal more competitive. The panel provided sufficient information for the Program Director to make a recommendation.
**Analysis:**
This proposal focuses on studying dynamic processes in nanostructures using near field optical microscopy techniques.

**Intellectual Merit:**
A research plan on fundamental study of materials, in particular dynamic processes related to carrier lifetimes, using near-field imaging is proposed. In panel's view, this proposal has some un-addressed issues in the technical plan. The panel would have liked to see discussion, for example, on usefulness of the proposed study, how the modifications to near-field system affect overall measurements, etc.

**Broader Impact:**
The panel generally agreed that the proposal is strong in the educational plan, underrepresented group student involvement and high-school student outreach activities. An international collaboration is also proposed.

**Reviewer Ratings:** V, V/G, V/G and V/G

This proposal was placed in the Do Not Recommend (DNR) category. Copies of the panel summary and the reviewer comments are attached. Based on the panel discussion, the Program Director's review, the highly competitive nature of the proposals submitted to the Electrical and Communications Systems Division, and budgetary constraints, this proposal is recommended for declination.

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**Panel Summary #1**

**PROPOSAL NO.:** 0348795

**PANEL SUMMARY:**
Proposal #0348795
PI: Andres LaRosa

**Goals:**
A study of near field imaging of materials dynamic processes at nanometer resolution is proposed.

**Intellectual Merits:**
**Strengths:** A research plan on fundamental study of materials using near-field imaging will be undertaken. In particular, dynamic processes related to carrier lifetimes will be studied. The PI has a good background in physics, industrial experience, and partnership with others.

**Weaknesses:** It was not obvious to the panel as to the reasons for the proposed study. Some of the modifications to near-field system may affect overall measurements but
discussions on this were not apparent from the proposal. Also, the type of detector that
will be used was not described in the proposal

Broader Impacts:
Strengths: The proposer shows a strong outreach activities. An international collaboration
is also present. High school outreach activities are quite realistic.

Summary Statement:
This is a good proposal of using near field to study materials dynamic response. Panel
recommends addressing some of the comments of the reviewers on the technical aspect of
the program.

PANEL RECOMMENDATION: Do Not Consider

Review #1

PROPOSAL NO.: 0348795
INSTITUTION: Portland State University
NSF PROGRAM: ELECT, PHOTONICS, & DEVICE TEC
PRINCIPAL INVESTIGATOR: La Rosa, Andres H
TITLE: CAREER: Near-field Imaging of materials dynamics processes at nanometer
resolution
RATING: Very Good

REVIEW:
What is the intellectual merit of the proposed activity?

A study of Near Field Imaging of Materials Dynamics Processes at Nanometer
Resolution is proposed. This technique will be used to study dynamic processes
associated with carriers in one aspect, and rapid characterization of microfluidic devices
in another aspect of the program. Of particular interest is the measurement
when the size is reduced to the nanoscale.

What are the broader impacts of the proposed activity?

The results from this program will find applications in a variety of fields of
nanotechnology. The educational component of the program will train students and
outrach activities to high schools will be done to attract students to nanotechnology,
science, and engineering.

Summary Statement

Overall, rating for this project is Very Good.
Review #2

PROPOSAL NO.: 0348795
INSTITUTION: Portland State University
NSF PROGRAM: ELECT, PHOTONICS, & DEVICE TEC
PRINCIPAL INVESTIGATOR: La Rosa, Andres H
TITLE: CAREER: Near-field Imaging of materials dynamics processes at nanometer resolution
RATING: Multiple Rating: (Very Good/Good)

REVIEW:
What is the intellectual merit of the proposed activity?

There are many components of high interest in this proposal. It was felt that the PI spent too much time discussing what NSOM is and it would be helpful to further discuss the details of the experiments proposed in place of the background discussion of NSOM. For example, as the NSOM probe approaches a nanostructure, how will the probe itself influence the quantum confinement of the nanostructure?

What are the broader impacts of the proposed activity?

The educational and outreach efforts are very well planned and nicely in place.

Summary Statement

The proposal has interesting aspects for the investigation of NSOM for applications of determining carrier dynamics in bulk and nanostructured semiconductors and for the study of microfluidics.

Review #3

PROPOSAL NO.: 0348795
INSTITUTION: Portland State University
NSF PROGRAM: ELECT, PHOTONICS, & DEVICE TEC
PRINCIPAL INVESTIGATOR: La Rosa, Andres H
TITLE: CAREER: Near-field Imaging of materials dynamics processes at nanometer resolution
RATING: Multiple Rating: (Very Good/Good)

REVIEW:
What is the intellectual merit of the proposed activity?

The PI is in the Physics Department at Portland State University and has an excellent background in the study of carrier dynamics in semiconductors with NFO. He has published on the subject and well qualified to carry out the research, education, and
outreach goals of the CAREER proposal. The proposal reads well and is very clear with good references. The PI never made the point as to the relevance of this study to the area of nanoscaled device research. The proposed activity is a little disorganized with the proposed studies not tied into a central theme.

What are the broader impacts of the proposed activity?

The broader impacts of this research will be the interdisciplinary nature of the proposed research as it crosses the boundaries between physics, materials science, and electrical engineering.

The proposal will advance discovery and integrate research into education with the development of new course materials at the graduate level, which is an integration of research and education. The benefit to society will be an understanding of carrier transport in semiconductor nanoparticles.

The outreach to the local community is very good with strong interaction between the PI and local high schools. The PI is obviously committed to developing this type of interaction and has developed a nice interaction with a university in Peru.

The PI has developed significant partnerships with universities and industry with strong support letters.

Summary Statement

The PI's CAREER proposal describes research to use near field optical microscopy techniques to study dynamic processes in nanostructures, such as (a) carrier dynamics in bulk and nano-materials (carrier lifetimes, free carrier absorption, excitons in quantum dots) and (b) fabrication of optical/microfluidic devices for imaging of macromolecules. The education program involves outreach to local high schools, partnerships with other universities, and an international component in South America (Peru). The major focus of the PI's research program is a fundamental study of the dynamics of materials under optical or electrical excitation with Near-Field Optical Imaging, where a single probe is scanned across a surface and the information is integrated for each pixel with feedback maintaining a tip-surface separation. In this instance, the material is at rest. This effort is combined with the fabrication of integrated nano-optical/mechanical devices to form an array of near-field probes to examine moving species, such as macromolecules, through microchannels and monitoring their dynamics.

In the measurement of carrier lifetimes, light (2mW AM pump beam) is directed on a sample through a nanometer-sized aperture whose vertical position (about 10nm) is controlled by electronic feedback and scanned laterally across the sample surface. While carriers are generated in the bulk sample, an IR laser beam
(1150nm, 1mW) provides free carrier absorption to monitor the decay of the excess carriers, which permits mapping of the carrier lifetime across the sample. These experiments will be extended to image silicon nanoparticles. The PI discusses relevant issues regarding the detection of excess carriers in nanoparticles and concludes there is sufficient sensitivity to study the dynamics of the excess carriers in the nanoparticles. In addition, the PI discusses the use of a near field optical/capacitance technique to characterize single electron devices, such as non-volatile SET memories.

The PI discusses a method to examine moving molecules, which is based on the fabrication of a near field multi-probe apparatus to combine with near field/microfluidic structures where the molecules are transported by electrophoresis. The basic technique is to maintain a stationary array of near field probes with molecules transported through microfluidic channels under the array. Thus, the need for electronic feedback is removed, which is inherently a slow process.

My comments are as follows:

Strengths: The PI is in the Physics Department at Portland State University and has an excellent background in the nanotechnology required to study the dynamics of excited carriers in bulk semiconductor materials as well semiconductor nanoparticles. He has a good university background with relevant industrial experience to help in the measurements and the construction of experimental equipment needed in the research. His publication record is good and indicates he should be able to carry out the proposed CAREER research, education and outreach program. The proposal is clear and well written. The references are thorough and the approach to the research is technically sound. There is good partnership developed with universities and industries. There is also an international component with a university in Peru. The PI demonstrates through some initial calculations there is the possibility of studying carrier dynamics in quantum dots and nanoparticles. The education program is sound and well developed. The PI has good support letters.

Weaknesses: The PI really never explains why the study of carrier dynamics is important in nanoparticles. In other words, why measure the lifetime of carriers in a single nanoparticles? How is this measurement related to nanoscaled device performance? What is the influence of the surface area on the expected carrier lifetime within nanoparticles?
RATING: Multiple Rating: (Very Good/Good)

REVIEW:
What is the intellectual merit of the proposed activity?

The PI is proposing to explore using near field optical microscopy techniques for studies of dynamic properties of semiconductor nanostructures. Specifically the PI proposed to study the carrier dynamics in semiconductor bulk and nanostructures. He has shown preliminary results on carrier lifetime obtained by near field imaging of bulk silicon. It is not clear if the study of e-h pairs dynamics in nanostructures is proposed and there also have been obtained some proof of concept experiments. Moreover, some of the proposed modifications of the near field microscope are not sufficiently articulated. The proposed electronic detection using phase locking is a good approach to increase sensitivity. However it is not clear what is the detection system and how well the pump and probe need to be isolated in the optical domain? The second focus area is concerned with using near field multi-probes for characterization of molecules confined in nanostructures. The proposed program may have a large impact on advancing the fundamental knowledge in the proposed areas, but there is a concern that most of the proposed work will be significantly depend on a large number of collaborators. Additionally, in my understanding, the PI is only in the initial stages of establishing his near field imaging facility and he does not discuss clearly the current status of existing and requested resources that are needed to build this instrument. Somehow the proposal gives a feeling that there is a significant part not in control of PI and this may affect the accomplishments of the proposed goals. No backup plan has been suggested.

The PI is a researcher with experience and track record in relevant research areas. His experience and background is suited to carry out the proposed research project. The essential resources are available to the PI at the proposer's institution and PI's Lab, but it is not clear if these will be sufficient to achieve the proposed goals. The education elements are sufficiently detailed (involvement of grad and undergrad students, strong relation with high school students, including diversity and underrepresented, element of international interactions).

What are the broader impacts of the proposed activity?

The PI has a past experience in education working with undergraduate and graduate students and involving them in the research projects carried out in his labs. He is also currently involved with local high school students. He is proposing to integrate the research into education by addressing new scientific advancements in his interactions and the lectures. The education program at the proposers institution and the PI are committed to involve underrepresented groups in research and education. The proposal has strong evidence of commitment of the PI and his institution to education and outreach programs.
The proposed research may have impact on the nanoscale science and technology via developing advanced high spatial resolution semiconductor nanostructure characterization tools.

Summary Statement

The proposed work is novel with high risk and high payoff if successful. The strength of the proposal is in the general methodology and evidence of some preliminary result. The weakness of the proposal is in some uncertainty in regards with the sufficient resources to build the near field instrument and that large portion of the proposed research depends on collaborators. A backup plan could be useful. The results of this research will contribute to nanoscale science and technology via developing advanced high spatial resolution semiconductor nanostructure characterization tools, and will certainly have an impact on education in this field.