

Request to Establish a Doctoral Program in Nanoscale Science at the University of North Carolina at Charlotte

Introduction

Following a recommendation from the Graduate Council and from the Senior Vice President for Academic Affairs, the Committee on Educational Planning, Policies, and Programs approved on January 13, 2005 the request from the University of North Carolina at Charlotte to plan a doctoral program in Nanoscale Science. The University of North Carolina at Charlotte now seeks approval to establish a doctoral program in Nanoscale Science (CIP: 40.9999) effective August 2007.

Program Description

Nanoscale science is a field of scientific investigation that addresses the development, manipulation and use of materials and devices on the scale of roughly 1-100 nanometers in length, as well as the study of phenomena that occur at this size scale (one nanometer equals one billionth of a meter). This size range encompasses the smallest man-made and naturally derived devices known. One can gain a perspective of the nanometer scale by considering the sizes of some familiar objects. For example, a sheet of paper is roughly 100,000 nanometers thick, critical dimensions in integrated circuits are less than 10 nanometers, while large polymers and proteins are just a couple of nanometers in size.¹

It is predicted that nanoscale science will change the nature of almost every human-made product this century. This field has great potential applications in materials, medicine, electronics, optics, data storage, advanced manufacturing, environment, energy, and national security. Some specific applications include: lightweight new materials with greatly improved strength and wear characteristics; ultra dense computer memory; better drug design and better drug and gene delivery; sensing applications for agricultural, biological, chemical and homeland security applications; improved catalysts for the chemical and automotive industries; new materials to improve fuel economy and carbon dioxide emissions; and improved batteries and energy efficient processes for energy technologies. Nanoscale materials already find use in numerous pharmaceutical, catalytic, electronic, magnetic, optoelectronic, biomedical, cosmetic and energy applications.

The challenges and opportunities of nanoscale science cannot be addressed by a single science or engineering discipline alone; the world's realization of the full potential and benefits of nanoscale science will require *collaborative, interdisciplinary* approaches to research.

To fully understand and develop efficiently the science and technology of the nanoscale regime, it will be vital to train and educate future scientists and engineers from both the molecular and macroscopic perspectives, and to ensure that they understand Nature's examples of working at the nanoscale. The proposed Ph.D. program will educate students about the field of nanoscale science from the perspectives of scientists and

engineers of several disciplines, and will provide students with the skills needed to conduct collaborative research in nanoscale science. Students possessing an undergraduate or master's degree in a relevant science or engineering discipline will develop a broad, integrated perspective of the field of nanoscale science by working with scientists and engineers of several disciplines in classroom and research settings, and they will also develop depth of knowledge in a chosen science or engineering discipline. Graduates of the Ph.D. program in Nanoscale Science will be well-prepared to engage in cutting-edge research and development in academic, national laboratory, or industrial settings. They will possess the expertise needed to train future generations of scientists and educators in the field of nanoscale science.

The educational objectives of the proposed Ph.D. program in Nanoscale Science are as follows:

- Provide students with knowledge and educational opportunities in pure and applied nanoscale science, culminating in an interdisciplinary, research-based Ph.D. degree in Nanoscale Science.
- Produce a supply of doctoral level scientists who will lead in (1) improving our understanding of the nanoscale regime and its many applications; (2) developing nanotechnology industrial initiatives in North Carolina and elsewhere; and (3) providing educational opportunities to train the workforce needed to sustain the growth of nanoscale science in North Carolina and the U.S.
- Develop and train independent scientists and scholars who possess the critical thinking, methodological, and communication skills required to advance and disseminate knowledge of fundamental and applied nanoscale science.
- Enhance the educational experience in science and engineering for all graduate and undergraduate students at UNC Charlotte.

Based on the combined strengths of faculty members in Chemistry, Physics and Optical Science, Mechanical Engineering and Engineering Science, Electrical and Computer Engineering, and Biology, the proposed program will focus on the following areas of research:

Theoretical Aspects of Nanoscale science

- Development of methods to model, synthesize, characterize, simulate and evaluate complex materials including photonic crystals, photonic devices and other complex materials such as high temperature superconductors and plasmonic devices.
- Modeling and predicting quantum effects that become significant in nanoscale materials, and utilizing these effects to develop new materials and applications (including quantum dots, quantum wires, nanotubes, and photon confined materials).
- Identification, understanding, and utilization of the concepts applicable to the controlled assembly of self-organizing nanomaterials, including polymers, dendrimers, nanotube-based materials, nanocatalysts at surfaces (including electrode surfaces), and assemblies of biopolymers.

Biomolecular Nanotechnology

- Design, fabrication, and optimization of biomaterials and devices for tissue growth and repair.
- Elucidation of structures of complex biomolecules and understanding interactions between biomolecules.

Program Review

The review process is designed to surface strengths and weaknesses in proposed new degree programs. Proposals to establish new doctoral programs are reviewed internally and externally. The concerns from the two review processes were summarized in a letter to the Chancellor prior to the presentation to the Graduate Council. That summary follows:

The reviewers are positively inclined toward the degree program in Nanoscale Science but they do express some concerns. One that runs through the internal and external reviews is the extent to which the program will be collaborative both with other universities and industry. This ranges from collaboration with other universities with complementary strengths to collaboration with industry through advisory committees that will help focus the curriculum to meet the needs of industry.

Another issue raised was a perception that the program may be more heavily oriented to engineering over biology and a prediction by one reviewer who thinks the next big things in nanotechnology will be in the biological arena. This was part of a suggestion that someone must be attentive both to promoting the interdisciplinary program and maintaining a balance among disciplines and faculty.

One reviewer had a list of equipment that he thought necessary for the research of the program but for which he did not find any discussion in the proposal.

Finally, there was a suggestion that somewhere in the curriculum there needs to be attention to issues of intellectual property and to the societal implications of advances in this field.

Graduate Council

The Graduate Council had, as a basis for its consideration, the proposal to plan the program, copies of the outside reviews of the program, the summary letter to the Chancellor, and a presentation to the Council by representatives of the program. The members of the Council did not raise any additional major issues.

Response

Representatives from the University responded to the reviewers' questions and comments. UNCC nanotechnology program is actively engaged in a wide range of collaborations with other universities and with businesses and industries. Among the universities where collaborations exist are UC Berkeley, Stanford, North Carolina State University, Wisconsin, MIT, UT Austin, and Michigan. The campus collaborates with

Clemson University in a program to get low cost access to research equipment, and with a number of companies locally and elsewhere through the Center for Precision Metrology which focuses on nanoscale metrology. Some examples are Boeing, Intel, and Caterpillar. Faculty has funded collaborations with a number of companies as well. Among them are Agilent Technology, General Dynamics, Corning, and Northrup Grumman.

UNCC sees its involvement in nanotechnology to have a very large biological component. This is particularly true of some of the research carried out in partnership with the Carolinas Medical Center.

The campus sees the choice of director of the program as key to melding this interdisciplinary program into a well functioning unit. It is clear in their position description and advertisements that this role is central for the director. Finally, intellectual property issues will be included in the course work for the degree program.

Need for the Program

Perhaps the most relevant quote is from the April 2006 Governor's Task Force on Nanotechnology and North Carolina's economy, "Nanotechnology will be as important to the future of North Carolina as biotechnology is to its present."

Resources

Due to new buildings and relocations no new space will be needed in order to accommodate this program. The program expects to secure most of its equipment through external grants. New salaries and operating funds will come from reallocations within the University (\$430,000) and new funding based on enrollment growth (\$315,000) in the first three years of the program.

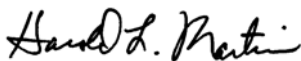
Recommendation by the Graduate Council

After consideration of the issues raised by reviewers and Council members, the Graduate Council voted, without dissent, to recommend approval for the University of North Carolina at Charlotte to establish a doctoral program in Nanoscale Science.

Recommendation

The staff of the General Administration recommends that the Board of Governors approve the request from the University of North Carolina at Charlotte to establish a doctoral program in Nanoscale Science.

Approved to be Recommended for Establishment to the Committee on Educational Planning, Policies, and Programs



Senior Vice President for Academic Affairs Harold Martin

January 3, 2007