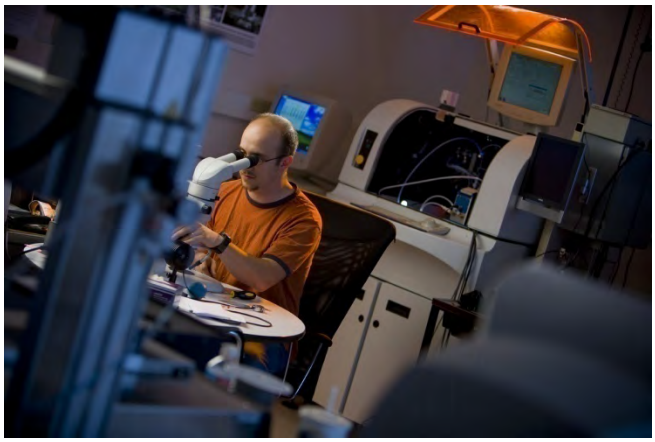
Nanoscience and Nanoengineering Ph.D.



Contact Information

Dr. Steve Smith
Nanoscience and Engineering
(605) 394-5268
E-mail: Steve.Smith@sdsmt.edu
http://nano.sdsmt.edu

Advisory Council

Professors Boyles, Kjerengtroen, Petukhov, Sandvig Professor Puszynski, Miller Professor Whites; Associate Professors Fong, Smith; Assistant Professors Ahrenkiel, Anagnostou, West, Zhu; Research Scientists Hong, Sears.

Nanoscience and Nanoengineering

The Nano Science and Engineering Ph.D. (Nano SE Ph.D.) Program at the South Dakota School of Mines and Technology is an interdisciplinary Ph.D. program focusing on the science and engineering of nanomaterials. The goal of nanoscience and nanotechnology is to manipulate matter at the atomic and "nano" length scales (dimensions from a few to 100's of atomic radii), e.g. the molecular to mesoscopic levels, where new materials and phenomena have been discovered. The ability to engineer systems at these length scales will require professionals with a broad understanding of fundamental principles and the ability to cross-over into other fields. The nano program provides the training to allow scientists and engineers to address these challenges, and the opportunity for students to engage in such research at the School of Mines while pursuing the Ph.D.

The Nano SE Ph.D. program offers a research-intensive degree focused on nanoscience and nanotechnology, with an emphasis on nano-scale materials. A multi-disciplinary core curriculum is taken by students from diverse science and engineering backgrounds. These "core" courses are intended to introduce students to contemporary topics in nanoscience and nanotechnology, and to initiate a cross-disciplinary approach to research and learning. These courses can usually be completed in one, or at most two years. In addition to this core, students entering with an M.S. degree are required to take at least two electives outside the student's traditional area of training. Students entering at the B.S. level will be expected to pursue, or take course work equivalent to, an M.S. degree, in addition to the nano core curriculum.

Students from traditional science and engineering backgrounds enter the program with well-defined research interests and affiliate themselves with a research group and a faculty mentor. Current nano program participants draw from the Departments of Chemistry and Physics, and Chemical, Electrical, Materials and Metallurgical, and Mechanical Engineering. Students with traditional training in these areas participate in cross-disciplinary research with a nano focus. Examples of active research areas are: synthesis and characterization of nanocomposite materials, photo-activated nano-inks for direct write applications, nano-energetic materials, polymer chemistry, theory of spintronic devices, and structural and optical characterization of nano-materials for solar energy, bio-fuels and other forms of renewable energy.

The nano SE Ph.D. program builds on traditional science and engineering disciplines, and offers a "core" curriculum which introduces students from varying science and engineering backgrounds to contemporary topics in nanoscience and nanotechnology. Students are expected to obtain graduate level training in a traditional discipline, designated as the "program major emphasis", and take a minimum of 6 elective credits outside their own area. Students

entering the program with an M.S. may apply up to 24 transfer credits toward fulfilling the program major emphasis requirements. More information is available in the Nano SE Ph.D. Program Handbook.

Students with an M.S. degree in science or engineering are eligible for admission. However, students with a B.S. degree only will also be considered for admission when the student has proven to possess exceptional qualifications. The Graduate Record Examination (GRE), three letters of recommendation, and a GPA of 3.00 or better are required of all applicants for the Ph.D. program. The TOEFL exam is required for students whose native language is not English.

All candidates for the Ph.D. program are required to successfully complete the following minimum credits and earn a grade of "C" or better, except for a final grade of "S" in NANO 898:

The program of study must be filed with the graduate office , and approved by the Nano SE Ph.D. program director before midterm of the second semester of residence, and again before the qualifying exam. Below is the summary of the required course of study.

Category	Credits	
NANO 701	Nano Materials	3
NANO 702	Theory and Applications of Nanoscale Material Systems	3
NANO 703	Instrumentation and Characterization of Nano-Materials	5
NANO 890	Seminar	3
Program Major Emphasis		26-36
Dissertation Research		30-40
TOTAL		**80**

General Program Requirements

(Minimum program requirements: (80 credits)

M.S. Degree (24 credits)

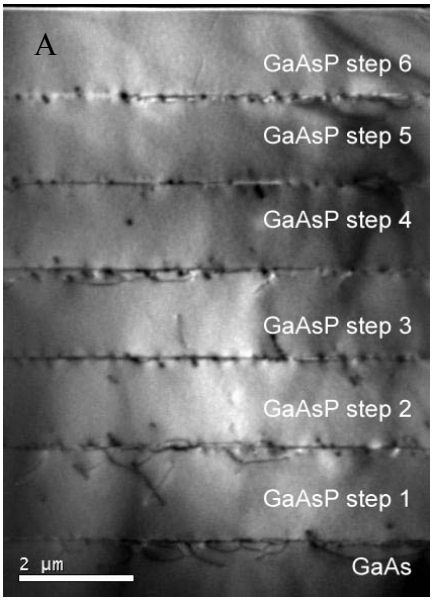
Students entering the Ph.D. program with a previous M.S. degree in a relevant discipline are allowed to apply a maximum of 24 semester course credit hours toward the course credit requirements subject to approval of the Dean of Graduate Education.

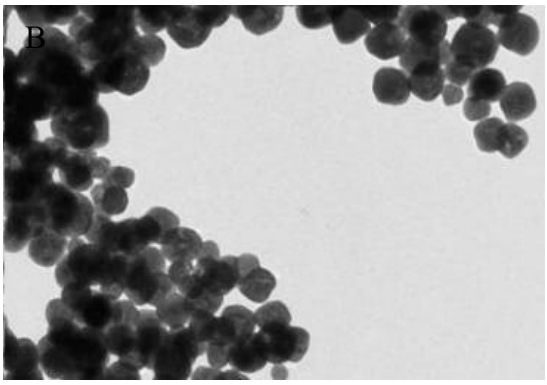
The following is a list of electives for each focus area of the program. Graduate level courses which serve the needs of our other graduate programs are also available as electives.

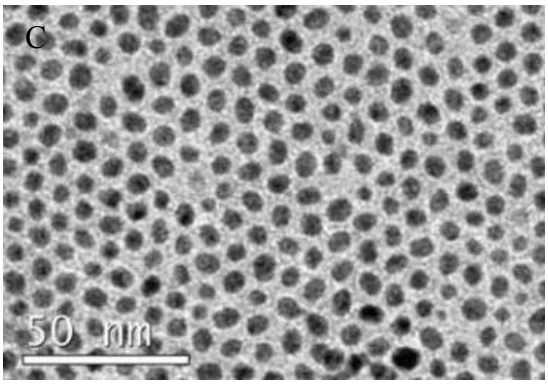
Category	Credits	
NANO 445/545	Introduction to Nanomaterials	(3-0)
NANO 504	Nanophotonics	3
NANO 604	Nanophotonic Materials	3
NANO 677	Printed Electronics	3
NANO 704	Crystallography and Structure of Nanomaterials	3
NANO 705	Nanoelectronics	3
NANO 706	Diffraction Methods for Nanomaterials Research	3
NANO 707	Defects in Nanoscaled Materials	3
NANO 708	Nanomaterials for Photovoltaics	3
NANO 711	Introduction to Direct Write Technology	3
NANO 712	Electromagnetic Properties of Heterogeneous Materials	3
NANO 713	Dielectric and Magnetic Properties of Nano-Scale Materials	3
NANO 714	Functional Fillers and Nanoscale Minerals	3
NANO 715	Polymeric Nanomaterials	3
NANO 716	Nanotechnology of Engineering and Construction Materials	3
NANO 717	Nano Chemistry	3
NANO 718	Small Scale Mechatronics	3
NANO 719	Atomic Force Microscopy/ Nano-Mechanics	3
NANO 720	Contemporary Condensed Matter Physics	3
NANO 791	INDEPENDENT STUDY	1 to 3
NANO 792	TOPICS	1 to 3
MES 601	Fundamentals of Materials Engineering	4
MES 603	Condensed Matter Physics	4
MES 604	Chemistry of Materials	4
MES 708/708L	Adv Instrumental Analysis	(3-1)
ME/ChE 612	Transport Phenomena – Momentum	3
ME/ChE 613	Transport Phenomena – Heat	3

ChE 614	Transport Phenomena – Mass	3
Phys 721	Adv Electricity and Magnetism	3
Phys 743	Statistical Mechanics	3
Phys 777	Quantum Mechanics I	3
Phys 779	Quantum Mechanics II	3
MES 712	Interfacial Phenomena	3
MES 713	Advanced Solid Mechanics	3
MES 728	Heterogeneous Kinetics	3
MES 737	Solid State Physics I	3
MES 770	Continum Mechanics	3

For program supervision purposes, the nano SE Ph.D. program director is the graduate advisor until the major professor is appointed. The major professor is responsible for the student's dissertation research. The graduate office representative on the student's dissertation committee must be selected from outside of the department with which the major professor is affiliated, and should also be a member of the Nano Ph.D. Advisory Council. It is not necessary that the student be associated with the department of affiliation of his or her major professor. Detailed information on examination policy, admission to candidacy, and defense of dissertation are included in the School of Mines nano science and engineering Ph.D. Program Handbook.







Examples of Nanomaterials synthesized and characterized at School of Mines: A: III-V hetero-junctions for advanced solar cells, B: Upconverting nano-particle phosphors for solar cells, C: Gold Nano-particles used in nano-composite materials.