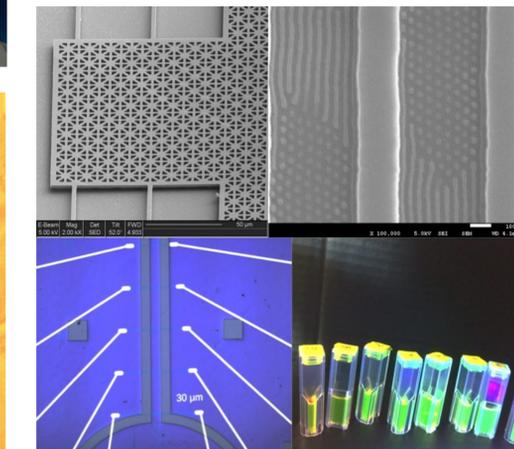




**Mark G. Allen, PI, Scientific Director, Singh Center for Nanotechnology,
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University of Pennsylvania**



- **Philosophy:** We are a 'maker space' for nanotechnologists that enables exploitation of fundamental advances in nanoscience to realize nanotech materials, devices and systems
- **4 core facilities:**
 - 10,000 sq. ft., class 100/1000 nanofabrication cleanroom
 - TEM, SEM, FIB, and ion beam scattering characterization
 - SPM, AFM, Raman/NSOM, TIRF/AFM probe techniques, several of which have been upgraded this year
 - Low temperature electron transport characterization
- **New Equipment**
 - 3 new state-of-the-art transmission electron microscopes have been ordered and will be installed in 2018: a FEI Krios G3i Cryo-TEM, an aberration-corrected JEOL 200kV NEOARM TEM, and a JEOL 200kV F200 TEM
 - Nanoscribe direct-write 3D printer with 600 nm resolution
 - Ultratech Fiji 200 Gen 2 Plasma ALD
 - Oxford PlasmaPro 100 Cobra etcher with F2 and Cl2 chemistries
- **Host of the Fall 2017 NNCI Conference**
 - Over 80 representatives of the 16 Member Sites, the NSF, and the NNCI External Review Board attended the 1.5 day meeting
 - Invited Speakers described research conducted here from an outside faculty perspective, and new tools soon to be installed at the Singh Center from the perspective of a new Penn Faculty member.
 - Meeting included an equipment and services vendor exhibit that featured 26 companies at an evening meet-and-greet
- **NNCI Network Activities**
 - MANTH-hosted Mid-Atlantic Cleanroom Managers' Meeting (50 attendees, including representatives from the NNCI Cornell site)
 - MANTH participation in NNCI-ASU Winter School (January) and REU Convocation (August)
 - MANTH Staff leadership in significant price reductions for maintenance contract and material cost reduction from preferred vendors (leveraging the network's buying power)
- **Research**
 - Over 500 researchers from academia and industry use the facility, resulting in over 220 conference talks and papers and 12 patents in calendar year 2016
 - Cleanroom staff published fabrication technical notes online with over 10,000 downloads worldwide in the past year
 - Penn researchers, using the Singh Center, created near-zero refractive index material (appearing as the cover article in Nature Photonics)
 - Researchers from another academic institution, Drexel University, used scanning probe microscopy to study the nanomechanics of cartilage components
 - Industrial users (EnaChip) developed nano-laminated ferromagnetic devices
- **Education and Outreach**
 - MANTH continues to organize and sponsor the Innovation Seed Grant Competition, designed to encourage individuals and companies from all around the Mid-Atlantic Region to design or prototype a wide range of technologies from many different disciplines, but all utilizing nanotechnology related tools and equipment. Winners are awarded \$5k to \$10k grants for Singh Center equipment use.
 - Created and hosted the Singh Nanovation Conference at Penn in order to bring together individuals from academia, government, industry and investment around the Mid-Atlantic region to discuss and showcase the current work being produced at the Singh Center.
 - Created a new graduate level laboratory course where students receive hands-on experience using state-of-the-art equipment in our research facility. Projects include fabricating and testing MEMS and Graphene devices, using electron beam lithography to demonstrate directed self-assembly, and synthesizing and characterizing quantum dots.
 - Host of the Nanoday@Penn for 155 high school students from 10 different schools with presentations, activities, and hands-on demonstrations. More than 150 Penn students assisted.
 - Hosted 6 REU students conducting research in nanotechnology this past summer.
 - Hosted the 2nd semi-annual Mid-Atlantic Cleanroom Managers workshop with 21 academic and government laboratories attending, and hosted the first 2 meetings in order to establish contacts, share process/equipment strengths, and exchange best practices.
 - Hosted at 1 day focus group of 12 participants from industry and government to explore the efficacy of an Associates Degree with a Nanotechnology emphasis with partner Community College of Philadelphia for workforce development.



Top: Participants of the October 2017 NNCI Conference at the Singh Center for Nanotechnology. Center: Students of the new graduate level nanofabrication and nanocharacterization lab course, and the devices and materials they fabricated. Bottom: Participants of the Nanoday Program, and the 6 Summer 2017 REU Students at Singh

