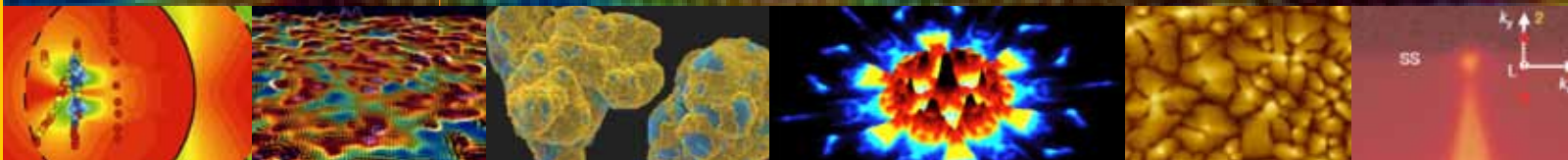


# Tailoring the Quantum and Structural Properties of Complex Materials for New Applications in Science and Engineering



Princeton University

The four interdisciplinary research groups (IRGs) in the Princeton Center for Complex Materials (PCCM) investigate a diverse array of unconventional materials, ranging from semi-metals and superconductors to organic semiconductors and block copolymers.

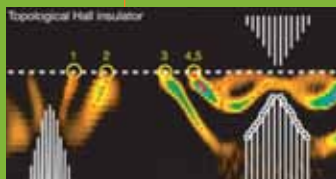
IRG-A is focused on a new class of materials called topological insulators. The surface electrons in topological insulators mimic elementary particles, e.g., the neutrino. Their novel properties suggest applications in future high-speed electronics and devices.

IRG-B investigates charge transfer and injection processes occurring at the interfaces of organic electronic devices. The interfaces are created by solution-based and solid-phase printing strategies, and by lamination and stamping. Advances in these

areas are essential for future low-cost electronics based on organic transistors.

IRG-C aims to create macroscopic designer arrays starting from building blocks as small as aromatic molecules to larger block copolymer nanodomains and fluid elements. Complex, centimeter-sized patterns have been created by applying shear, electrohydrodynamics, and confining surfaces.

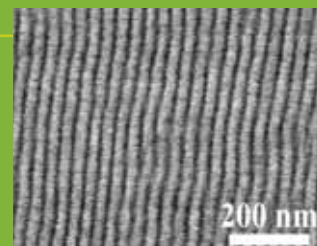
Finally, IRG-D is developing tools to manipulate individual electrons trapped in nano-systems, for example, nanowires less than 100 atoms across. Short voltage pulses are used to shuttle the electrons between adjacent wells. A goal is to optimize materials for quantum computing.



## HIGHLIGHTS . . .

PCCM researchers have confirmed that the surface electrons in topological insulators have novel quantum properties.

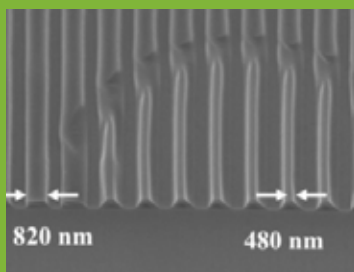
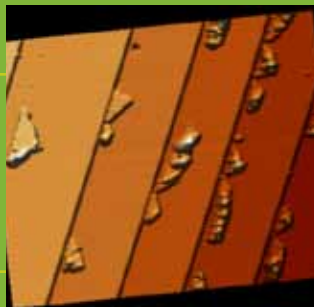
Block copolymer templates were used to fabricate large-area arrays of parallel silicon wires with very high resolution (16 nm).



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<http://www.princeton.edu/~pccm/>

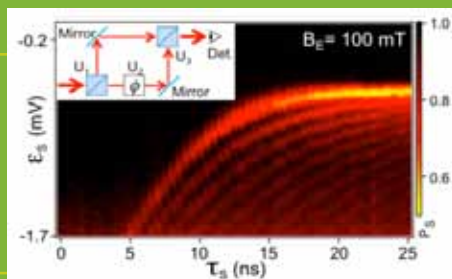
## RESEARCH FUNDAMENTALS . . .

PCCM researchers are synergistically researching the novel quantum properties of topological insulators.



Organic transistors are the key components of low-cost flexible electronics.

PCCM researchers have found that controlled shearing of thin polymer films produces a periodic structure extending over several centimeters.



Addressing critical needs of society in the next decade will require major advances in the science of complex materials. //

N. Phuan Ong, Director  
PCCM



## PCCM'S OUTREACH AND PARTNERSHIPS...

- **Princeton University Materials Academy PUMA:** Summer school for minority high- and middle-school students.
- **Science & Engineering Expo:** One-day expo drawing 1000 middle school students.
- **REU - Research Experience for Undergraduates:** 9-week summer course for undergraduates.
- **Condensed Matter Summer School:** Advanced topics school for graduate students.
- **Professional development:** Materials science programs for teachers and RET program.
- **Partnership for Research and Education in Materials (PREM):** Partnership with California State University Northridge.
- **Liberty Science Center (LSC):** Partnership with LSC in setting up science exhibits.
- **Imaging and Analysis Center (IAC):** Advanced electron microscopes and analytical equipment are used regularly by local industries and universities.

# OUTREACH

More information about the workshops, internships, partnerships, and educational opportunities are available at:  
<http://www.princeton.edu/~pccm/outreach/index.htm>

