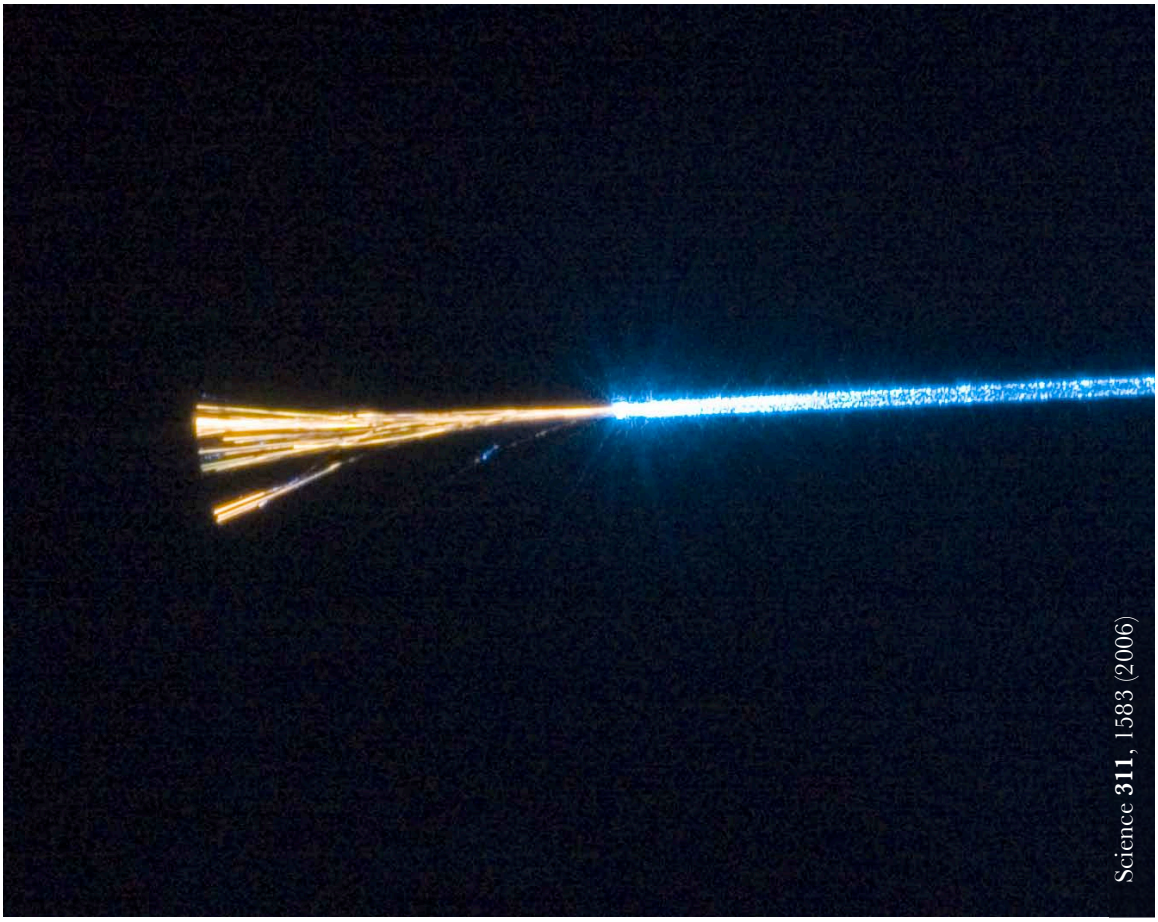
FIBER INTEGRATION

Penn State MRSEC

Penn State researchers have developed the first in-fiber crystalline semiconducting devices, putting us on the threshold of a new era in integrated fiber optoelectronics



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Semiconductors encased in glass: a new platform for optoelectronics

IRG4

Penn State researchers John Badding, Venkat Gopalan and Vincent Crespi, working in close collaboration with Pier Sazio at the University of Southhampton, have succeeded in a task that at first sight may seem impossible: depositing uniform, dense conformal semiconducting nanowires deep within the pores of microstructured optical fibers. The resulting silicon and germanium nanowires are by far the longest nanowires ever produced: tens of centimeters long, yet with inner pores so small that they cannot be resolved by scanning electron microscopy.

Badding and collaborators have extended the technique to produce radial semiconducting and metal/semiconductor heterostructures, field-effect transistors, infrared waveguides, optical modulators, compound semiconductors, metals, and even single-crystal silicon, all integrated intimately into the optical fiber geometry. In-pore photochemistry initiated by light focussed through the side of the fiber enables controlled placement of gold seed particles in three-dimensional arrays for fluid-liquid-solid growth of crystalline silicon.

Ultrahigh pressure, which can be sustained due to the great mechanical strength of high-quality optical fibers, facilitates mass transport into these highly confined spaced and induces the exceptionally uniform conformal filling that is necessary to obtain nearly perfect filling of these extreme aspect ratio pores. By integrating the design flexibility of microstructured optical fibers with the compositional control of chemical vapor deposition, this research may define a new generation of device geometries.