

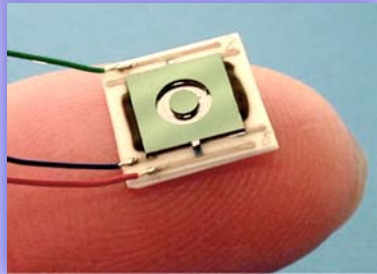


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High sensitivity accelerometers are fabricated on a 6mm square die.

Trolier-McKinstry Group
Penn State



A LEADER IN INTERDISCIPLINARY RESEARCH



"Penn State's Keck Smart Materials Integration Lab has been key to the development of our product, which is based on Keck SMIL's PZT Solgel films.

Penn State's facilities are a great benefit to industry in Pennsylvania."

Julian Richards
Vice President for Engineering
Bridge Semiconductor
Pittsburgh, PA

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**W. M. KECK
SMART MATERIALS
INTEGRATION
LABORATORY**



Advanced electroceramic materials are enabling new devices and emerging technologies. At Penn State, faculty, staff, and students explore the properties of materials in real-world applications through the fabrication of devices in the W. M. Keck Smart Materials Integration Laboratory (SMIL). By integrating materials into prototype devices, students gain hands on experience. Industry benefits as new materials and devices are tested and improved in the lab.

A smart material senses a change in its environment and responds to that change in a useful way. In the Keck SMIL, scientists are creating a new generation of smart integrated components that combine electrical, mechanical, and optical functions.

- ◊ Smart piezoelectric sensors and actuators
- ◊ Metamaterials
- ◊ All-optical circuits that can process light at gigahertz frequencies
- ◊ Tunable dielectrics for microwave communication
- ◊ Integrated passive components
- ◊ Nanotube based solar cells
- ◊ High frequency ultrasound for nondestructive investigation of organs and cells



Prototype complex oxide based infrared sensor arrays are being fabricated using PZT materials and fabrication processes developed at Penn State. The sensor arrays have been integrated into infrared cameras and show great promise for low cost thermal imaging systems.

Bridge Semiconductor
Pittsburgh, PA

Keck SMIL is:

A rapid prototyping center providing expertise to industry and users across campus with capabilities in the following areas:

- ◊ **Thin films** – Metallization and a wide variety of piezoelectric, pyroelectric, dielectric, and resistive thin films can be grown and patterned
- ◊ **Thick Films** – Low temperature co-fired ceramics, coatings, patterning and lay-up facilities, multilayer capacitors and actuators
- ◊ **Characterization** – Ferroelectric films, dielectrics, and nonlinear optical materials

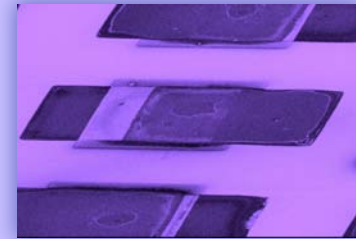


Resonant metamaterial - high-permittivity dielectric resonators embedded in a low-permittivity matrix for microwave transmission.

Lanagan Group,
Semouchkina
Penn State

Keck SMIL provides:

Keck SMIL provides expertise in complex oxide thin film deposition (piezoelectrics and pyroelectric films) and patterning to the National Science Foundation's National Nanotechnology Infrastructure Network (NNIN) and the Penn State NNIN site.



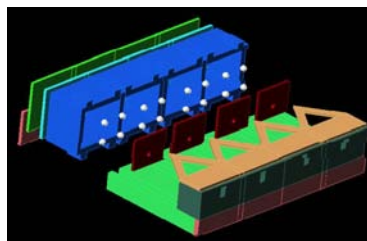
Multilayer thin film capacitors fabricated using microcontact printing.

Trolier-McKinstry Group,
Randall Group
Penn State

Kemet Electronics Corp.
South Carolina

R&D 100 Award

Devices such as this R&D 100 award winning optical fiber alignment package made of low temperature co-fired ceramic are fabricated in the Smart Materials Integration Laboratory. The device, based on research by faculty and graduate students in Penn State's International Center for Actuators and Transducers and the Center for Dielectric Studies, offers an economically viable method of aligning and realigning optical fibers.



Uchino Group, Randall Group
Penn State

A researcher deposits a PZT film via spin-coating on 4-inch wafers in the Keck SMIL class 100 cleanroom.

