Research team develops 'smart' window

April 9 2015, by Evan Lerner

This illustration shows how a full-sized “smart” window could switch from transparent to an opaque pattern, via a motorized stretcher hidden in the frame. Credit: Jenny Sabin

Commonplace as they are, windows are an important piece of

technology. Beyond architectural aesthetics, a building's ecological footprint depends heavily on how its internal light and heat are managed. With this in mind, researchers from around the world are trying to make windows "smarter" by tailoring their properties to be more responsive and finely tuned to changing needs.

At Penn, Shu Yang, a professor in the School of Engineering and Applied Science, is taking a deceptively simple approach to the smart window. By infusing a clear silicone sheet with nanoscopic glass beads, she and her colleagues have made a material that switches from transparent to opaque and colored when it is stretched.

Such a material could be sandwiched between two panes of glass and stretched by a motor, or deployed more like a window shade and stretched by hand.

The team, which includes members of Yang's lab, postdoc Dengteng Ge and grad student Elaine Lee, as well as assistant professor Daniel Gianola, has published a new paper in the journal *Advanced Materials* that outlines this concept.

Other smart window approaches involve electro-sensitive chemicals that change color when a voltage is applied, but they switch slowly, and are costly and prone to failure. The Penn team's version reduces this complexity by taking advantage of structural color, which is produced when many tiny objects collectively interact with light.

"Because the reflective index of the beads match that of the silicone sheet, you don't see anything at first," Yang says. "Once you stretch it, however, you create air pockets around the beads. The air has a very different reflective index, which means that the beads can show off their color and the material becomes opaque."

The beads can be sprayed into the silicone using a stencil, creating patterns that are only revealed once the material is stretched. Because the color they appear is a product of the size of individual beads, different windows can be easily tailored to have different properties, such as blocking more or less ultraviolet or infrared light.

"Beyond the aesthetics, having structural color is advantageous because it reflects light, rather than just blocking or absorbing it," Yang says. "That prevents heat from coming in on a scorching summer day, and it's something we're going to be developing further."

Some of that work will be completed through a collaboration Yang is spearheading between researchers at Penn Engineering, the School of Arts & Sciences, PennDesign, and other universities, and will explore how this smart window can improve the energy efficiency of buildings.

Provided by University of Pennsylvania