Smart windows that go from clear to dark in under a minute

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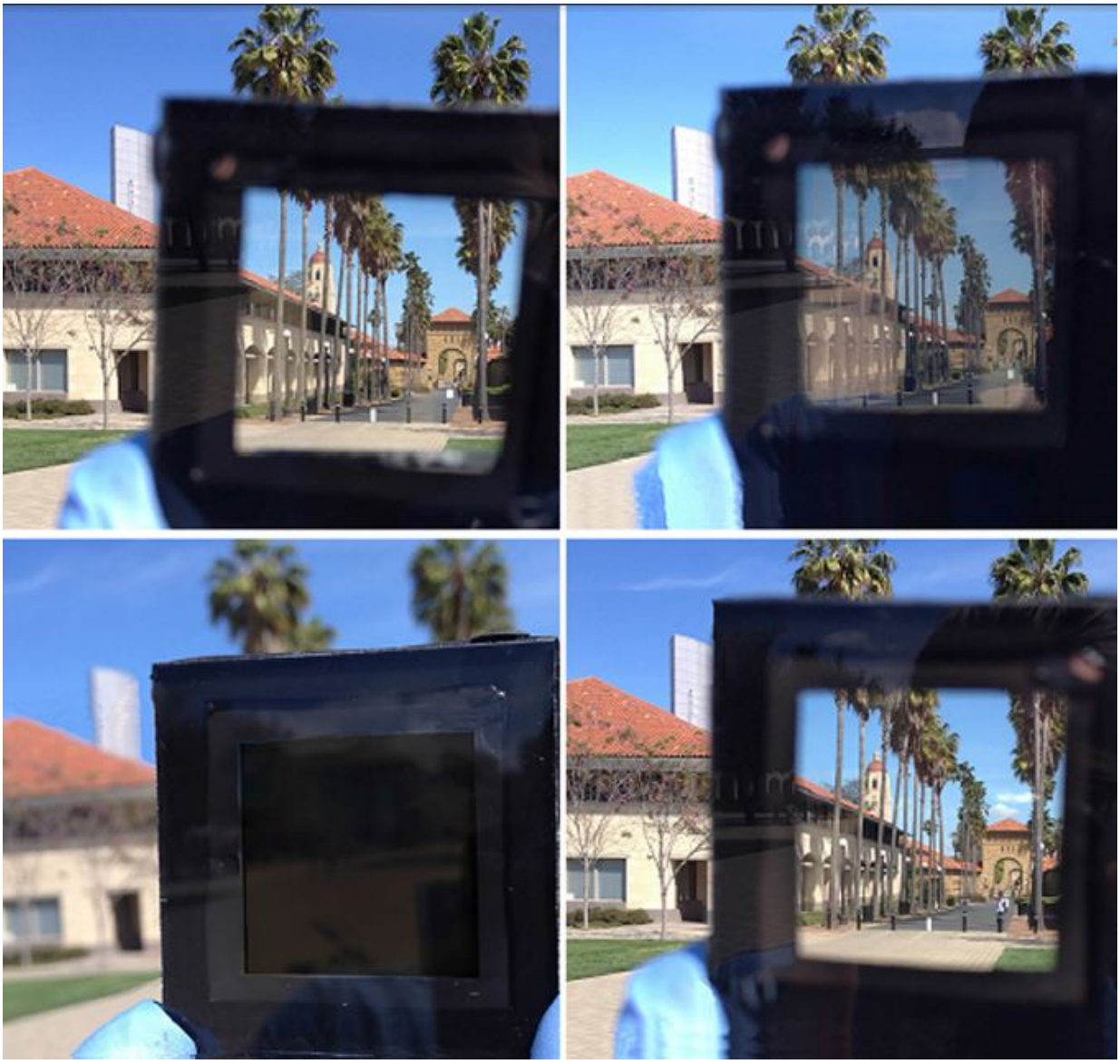

Smart window prototype dimming in response to electricity. This window is

notable for possessing neutral color, high contrast, and excellent durability. Credit: Yue et al./Joule 2017

Stanford University engineers have developed dynamic windows that can switch from transparent to opaque or back again in under a minute and do not degrade over time. The prototypes are plates of conductive glass outlined with metal ions that spread out over the surface, blocking light, in response to electrical current. The group recently filed a patent for the work, presented August 9 in the journal *Joule*, Cell Press's new publication for energy research and green technology.

Dynamic windows have the potential to transform our homes, businesses, cars, and more, reducing heating and cooling costs or the need for blinds, but even though the technology exists, it has yet to really catch on in the marketplace. Smart windows already being sold, such as those used on airlines, are made of materials, such as tungsten oxide, that change color when charged with electricity. But these materials tend to be expensive, have a blue tint, can take over 20 minutes to dim, and become less opaque over time.

"We did not tweak what was out there, we came up with a completely different solution," says senior author Michael McGehee, a Stanford University professor of materials science and engineering with a background in solar cells. "We've had a lot of moments where we've thought, 'how is it even possible that we've made something that works so well, so quickly,' and we're now running the technology by glass and other kinds of companies."

McGehee and his group's prototype blocks light through the movement of copper and another metal in a solution over a sheet of transparent indium tin oxide modified by platinum nanoparticles. When transparent,

the windows are clear and allow about 80 percent of surrounding natural light through, and when dark, transmission drops to under 5 percent. The researchers switched the windows on and off at least 5,500 times and saw no change in the transmission of light, indicating that the design is durable.

There is still work to do before scaling up, however. McGehee says that there is currently a limit in how much area the prototypes can cover (the study looked at 25 cm2 windows), but there are plans to address this problem. His group also wants to iterate the metal electrodes. The goal is to cut the cost of the prototype so that it is at least half the cost of dynamic windows that are already on the market.

"We're excited because dynamic window technology has the potential to optimize the lighting in rooms or vehicles, save about 20% in heating and cooling costs, and even change the way people wear sunglasses" McGehee says. "This is an important area that is barely being investigated at universities, and there's a lot of opportunity to keep us motivated."

More information: *Joule*, Yue et al: "Dynamic Windows with Neutral Color, High Contrast, and Excellent Durability using Reversible Metal Electrodeposition" www.cell.com/joule/fulltext/S2542-4351(17)30001-6 , DOI: 10.1016/j.joule.2017.06.001

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