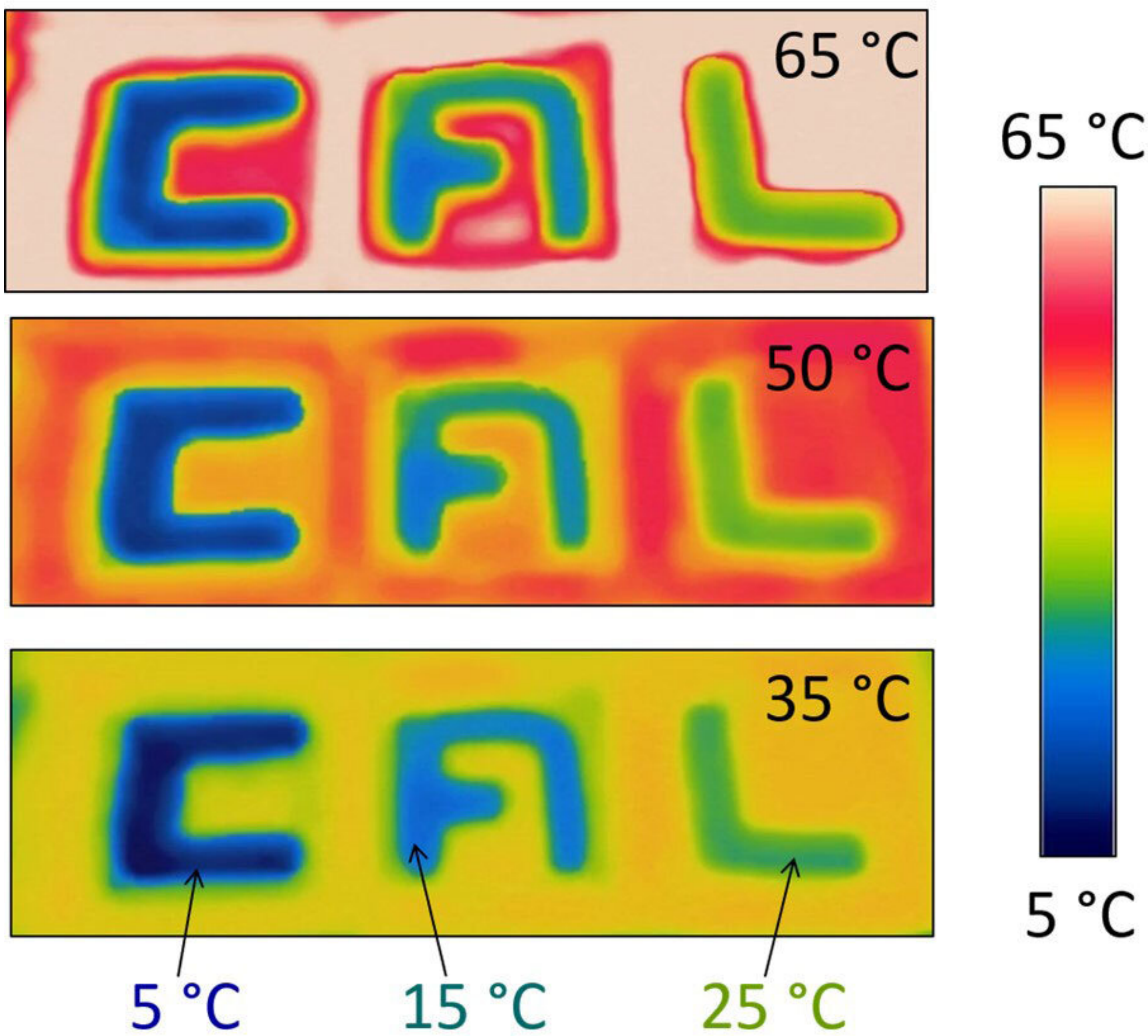
Researchers create 'decoy' coatings that trick infrared cameras

July 27 2020, by Thomas Lee



The letters C-A-L appear cool even when the environment is hot. UC Berkeley engineers develop a decoy that fools infrared cameras into perceiving a designated temperature rather than the actual temperature of the object. Credit: Kechao Tang

Light can sometimes play tricks on our eyes. If you look at a shiny surface, what you see will largely depend on the surrounding environment and lighting conditions.

Berkeley researchers have now taken ocular distortion a step further, finding a way to imbed visual "decoys" into surfaces of objects in a way that can fool people into thinking they detect a specific image in the infrared that actually isn't there.

In a new paper published today in the journal *Advanced Materials*, Junqiao Wu, UC Berkeley professor of materials science and engineering, and post-doctoral researcher Kechao Tang described a process in which they created special structures made from delicately engineered thin films of tungsten-doped vanadium dioxide.

Infrared light is invisible to the human eye, but can be detected by a range of devices, such as night-vision goggles and thermal-imaging cameras. The coatings developed by Berkeley researchers can effectively tune target objects into emitting the same infrared radiation as the surrounding environment, making them invisible to infrared detection devices.

But what makes the researchers' work particularly novel is that they can manipulate the coatings in a way that a person trying to view the object with such a device would instead see a false image.

"This structure offers a general platform for unprecedented manipulation and processing of infrared signals," the researchers wrote in the paper.

To create the structures, Wu and his team focused on coating objects with tungsten-doped vanadium dioxide, a substance that at certain temperatures can phase shift from an insulator, which suppresses electric conductivity, to a metal, which conducts electricity.

With judicious engineering of the doping profile, the insulator-metal phase transition can even out, allowing the substance to emit a constant level of thermal radiation over wide range of temperature variations (15-70 degrees Celsius). This state of equilibrium prevents a camera from detecting the true infrared signals that an object normally emits around room temperature.

Other researchers have explored concealing infrared emissions with different phase-changing materials. Previously, scientists at the University of Wisconsin at Madison experimented with samarium nickel oxide, while engineers at Zhejiang University in Hangzhou, China focused on germanium-antimony-tellurium to achieve thermal camouflage.

But Berkeley researchers, backed by the National Science Foundation and the Bakar Fellows Program, say their technology represents several advancements. They grew ultra-thin layers of vanadium dioxide (less than 100 nanometers thick) on structures made from borosilicate glass and sapphire. Using pulsed lasers, researchers doped the films with different amounts of tungsten and then transferred the material onto a special adhesive tape called polyethylene (PE) film tape.

The researchers say this method provides better, more consistent camouflage because the product is mechanically flexible, power free and inherently self-adaptive to temporal fluctuation as well as spatial variation of the target temperature.

Additionally, by manipulating the configuration and composition of tungsten-doped vanadium dioxide on coatings applied to the PE tape, researchers can create an infrared decoy.

"How we grow the material changes the image people ultimately think they see," Wu said.

In the paper, researchers described encoding the letters C-A-L onto samples that they later placed on the surface of an object. The color of the letters represents the temperature people see when viewing from an infrared camera. For example, the blue C shows it is at a constant 5 degrees Celsius, the lighter blue A at a constant 15 degrees Celsius, and the green L at a constant 25 degrees Celsius, regardless of the actual temperature of the samples.

Even though the object's actual temperature varies widely from 35-65 degrees Celsius, a person who views the object through night-vision goggles will distinctly see a colder "CAL" that is independent of the actual temperature.

"We can both erase real information and create false information," Wu said, "CAL stays cool when the environment is hot."

This kind of technology could prove useful for military and intelligence agencies, as they seek to thwart increasingly sophisticated surveillance technologies that pose a threat to national security. It might also incubate future encryption technology, allowing information to be safely concealed from unauthorized access.

More information: Kechao Tang et al. A Thermal Radiation Modulation Platform by Emissivity Engineering with Graded

Metal–Insulator Transition, *Advanced Materials* (2020). DOI: 10.1002/adma.201907071

Provided by University of California - Berkeley