Adaptive thermal camouflage

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In nature adaptive coloration has been effectively utilized for concealment and signaling[1]. Various biological mechanisms have evolved that can tune the reflectivity for visible and ultraviolet light. These examples inspire many artificial systems for mimicking adaptive coloration to match the visual appearance to their surroundings[2,3]. Thermal camouflage, however, has been an outstanding challenge which requires an ability to control of the emitted thermal radiation from the surface. Here we report a new class of active thermal surfaces capable of efficient real-time electrical-control of thermal emission over the full infrared (IR) spectrum without changing the temperature of the surface. Our approach relies on electro-modulation of IR absorptivity and emissivity of multilayer graphene via reversible intercalation of nonvolatile ionic liquids. The demonstrated devices are light (30 g/m^2), thin and ultra-flexible which can conformably coat their environment. In addition, we show that these devices can disguise hot objects as cold and cold ones as hot in a thermal imaging system. We anticipate that, the electrical control of thermal radiation will impact on a variety of new technologies ranging from adaptive IR optics to heat management for outer space applications.

Figures

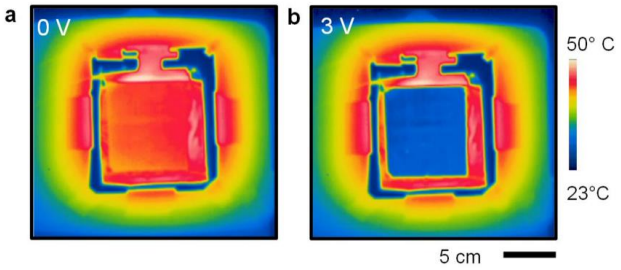

Figure 1: Thermal camera images of the fabricated device biased at 0V to 3 V respectively

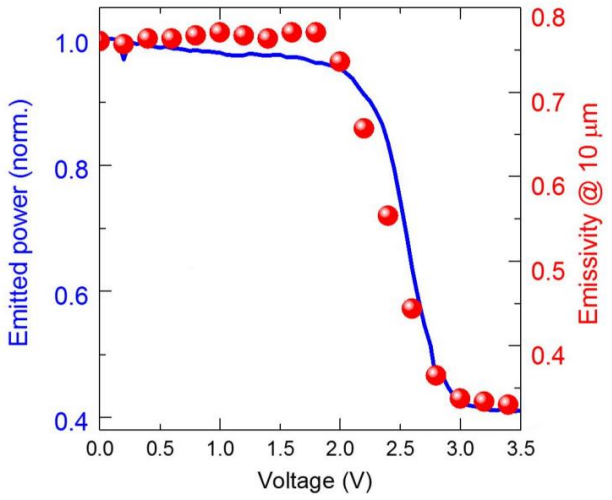

Figure 2: Voltage dependence of the emitted thermal power (blue line) and extracted emissivity (red scattered data) at the wavelength of 10 µm

References

[1] Ramachandran, V. S. et al, Nature, 379(1996) 815- 818

[2] Yu, C. J. et al, PNAS 111(2014), 12998-13003

[3] Han, S. E. & Norris, D. J, Phys Rev Lett 104(2010),043901