Two independent teams build heat cloaking device

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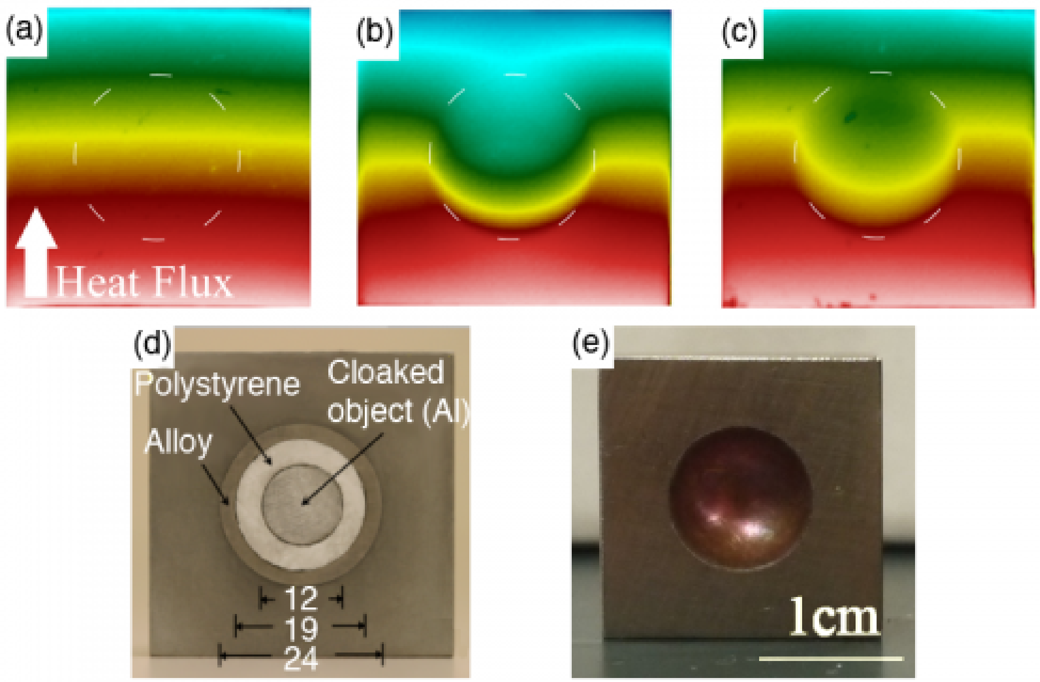

(a) Temperature distribution in a uniform medium connecting a hot (bottom) and a cold region (top). (b) The distribution is distorted in the presence of an obstacle (an air bubble in this example). (c) Adding a thermal cloak restores the transient diffusion and isothermal lines all around the obstacle. (d) Cross section of sample used by Han et al. [1]. (e) Cross section of molded cloak used by Xu et al. [2]. Credit: Physics Viewpoint, DOI: 10.1103/Physics.7.12

(Phys.org) —Two teams, both in Singapore have created two different types of thermal cloaking devices. In their papers, both published in

Physical Review Letters, the teams describe how they went about creating their devices and offer suggestions as to what use they might be put.

Cloaking has a become a hot topic in science, and not just because of the popularity of Harry Potter. With the advent of metamaterials, scientists discovered they were able to create devices that bent microwaves—the first cloaking devices. Such devices were followed up by other devices that bent light and infrared radiation and sound—all cloaking devices which worked because of the way metamaterials were able to bend wave based media. In this new effort, the two research teams applied some of the same ideas to heat, which is of course, not a wave media—it moves via diffusion and therefore does not propagate. But, the researchers noted, that doesn't mean under certain circumstances it too can't be cloaked.

The idea behind cloaking heat is to create an environment where heat diffusion does not occur into an object placed into that environment—instead, like wave cloaking, the heat is caused to stray from its normal path and move around the object instead of into it.

The first team created a heat cloak by binding strips of metal and polystyrene together and then placing the result inside of a block made of thermal conducting material. The dimensions of all the materials were adjusted to meet those specified by a mathematical formula based on thickness and conductivity. The arrangement allowed for thermal cloaking of an aluminum cylinder placed inside.

The second team created their device by trapping a pocket of air inside a block made of stainless steel—the air pocket was lined with copper. An object placed inside the air pocket was heat cloaked.

Neither group has a specific application in mind for their heat cloaking device, but suggest heat cloaking might be useful for managing heat in electronic circuits. One such application might be inside of cell phones as way to prevent batteries from overheating. Both teams note that another result of their work is that they have proven that diffusion cloaking is possible which means it might be applied in other areas, such as with tomography or static currents.

More information: 1. Tiancheng Han, Xue Bai, Dongliang Gao, John T. L. Thong, Baowen Li, and Cheng-Wei Qiu, "Experimental Demonstration of a Bilayer Thermal Cloak," Phys. Rev. Lett. 112, 054302 (2014). dx.doi.org/10.1103/PhysRevLett.112.054302

2. Hongyi Xu, Xihang Shi, Fei Gao, Handong Sun, and Baile Zhang, "Ultrathin Three-Dimensional Thermal Cloak," Phys. Rev. Lett. 112, 054301 (2014). dx.doi.org/10.1103/PhysRevLett.112.054301