Research team scores a first with effective thermal camouflage

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Engineers and scientists have been trying to discover the ultimate "cloaking" device – not just as a hat trick to make things invisible—but for its applications in defence technology. Now, a team from the NUS Department of Electrical & Computer Engineering led by Dr Qiu Chengwei, has successfully developed a thermal illusion device to control thermal camouflage and invisibility using thermotic materials. Thermotics is a branch of science dealing with heat and thermodynamics.

Every natural object exhibits thermal signatures. However, if these signals are blocked or masked, then the objects become undetectable. If you can remember the *Predator* movie (starring Arnold Schwarzenegger) – the creature is invisible and is also effectively camouflaged to blend in with its surroundings making it difficult for it to be tracked down. But this hi-tech creature has an advantage over its hunters as it detects them using thermal imaging.

A "predator" like the one in the movie is, to some extent, actually realisable, using Dr Qiu's invention. His device could block thermal signatures (leading to invisibility) and provide illusionary camouflage at the same time. He and his team's findings were published recently in *Advanced Materials* as well as *Physical Review Letters*. Besides academic journals, the researchers' breakthrough has also been extensively highlighted by online scientific publications in the US and UK.

Said Dr Qiu, "This is the first time that such a cloak has been proven to

work effectively, based on thermotics. Our success means that now we have a cloaking technology that is cost-effective and easily scalable and applicable to even bigger objects such as soldiers on night missions. We have managed to control the thermal illusions' shapes, material properties, distributions, and locations using bulk natural materials without sophisticated fabrication. This drastically overcomes practical and challenging limitations of metamaterials which are not found in nature and hence would require complicated and complex design to imbue them with special properties. Our new technology has also overcome limitations like narrow bandwidth and polarisation-dependence."

The team comprising Dr Qiu, Dr Han Tiancheng, Ms Bai Xue, Associate Professor John T L Thong and Professor Li Baowen (NUS Department of Physics), has carefully investigated their device in both time-dependent and temperature-dependent conditions and have found it to demonstrate excellent thermodynamic performance. The technology is ready to roll out for military applications.

Their research has also introduced a new dimension to the emerging field of "phononics" which is the controlling and manipulating of heat flow with phonons (particles which transmit heat within solid materials). A spinoff application of their research, said Dr Qiu, would be in heat management of highly packed electronic circuits, interconnectors and batteries.

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