MATERIAL WITNESS

COULD POLYTHENE CLOTHES BE COOL?

Restaurant signs that boast of air-conditioning have a certain allure in countries with humid, tropical climates, but one wonders if the prospect of relief might soon be trumped by feelings of guilt. Air-conditioning has huge energy costs, and ironically these may grow dramatically if the world is warmed by precisely this kind of convenience-driven fuel consumption. Even 5 years ago, 40% of electricity use in Mumbai went on air-conditioning, and some predict that it will contribute to making Saudi Arabia a net importer of oil by 2025.

Is there a better way of staying cool than filling our entire living spaces with blasts of cold air? There is, but cooling technologies that work at the level of individual people are generally expensive and/or cumbersome, and so are limited to specialized situations, for example in the military or sports. A common solution is a fabric that, thanks to hydrophilic fibres, wicks sweat from the body to the outside of the garment so that it can continue to provide evaporative cooling. It's not cheap, but more to the point, you have to be already sweating before it can work — fine for the sportsperson, less so for the diner. Cold packs containing a substance that undergoes a phase change close to body temperature can draw away body heat as latent heat — but these are bulky and need recooling periodically.

The human body is actually fairly good at shedding excess heat even before breaking into a sweat, by radiating it as infrared (IR) radiation. But clothing inhibits this. Tong *et al.* (preprint at http://arxiv.org/abs/1507.04269; 2015) suggest that cheap passive cooling might be achieved with a fabric that is transparent to IR yet opaque to visible light. But can that be made?

The researchers calculate that, if a wearer is to feel comfortably cool at a temperature of 26 °C, the material needs to have an IR transmittance of at least 0.644 and IR reflectance of no more than 0.2. Some common polymer fibres, such as polyethylene and nylon, have an intrinsically high IR transmittance because they lack vibrational modes in the IR range, and their IR transparency can be increased by reducing the diameter of the yarn (the fibre bundles) and of the individual fibres.

However, the trick is to keep the visible reflectance high, since no one is going to wear near-transparent clothing. This is a question of balancing the Rayleigh scattering of IR radiation — the scattering regime for particles much smaller than the wavelength of the light — against the Mie scattering of visible radiation, which is the relevant regime when the scatterers are of comparable size to the wavelength. The numerical simulations of Tong *et al.* indicate that a polyethylene yarn of 30 μm width, made from fibres just 1 μm thick, will have a far-IR transmittance and reflectance of 0.972 and 0.021, very comfortably reaching their target values, while Mie scattering will make them appear opaque white. Drawing such fine polyethylene threads would be challenging, but should be feasible. The question then is: how will such a fabric hang, and how will it feel? ❐

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