Scientists Formulate Intelligent Glass That Blocks Heat Not Light

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Soaring air conditioning bills or suffering in the sweltering heat could soon be a thing of the past, thanks to UCL chemists.

Reporting in the Journal of Materials Chemistry, researchers reveal they have developed an intelligent window coating that, when applied to the glass of buildings or cars, reflects the sun's heat so you don't get too hot under the collar.

While conventional tints block both heat and light the coating, which is made from a derivative of vanadium dioxide, allows visible wavelengths of light through at all times but reflects infrared light when temperature rise over 29 degrees Celsius. Wavelengths of light in this region of the spectrum cause heating so blocking infrared reduces unwanted rays from the sun.

The coating's ability to switch between absorbing and reflecting light means occupants benefit from the sun's heat in cooler conditions but when temperatures soar room heating is reduced by up to 50 per cent.

Professor Ivan Parkin, of UCL's Department of Chemistry and senior author of the paper, says:

"Technological innovations such as intelligent window coating really open the door to more creative design. The current trend towards using glass extensively in building poses a dilemma for architects. Do they tint the glass, which reduces the benefit of natural light or face hefty air conditioning bills?

“While the heat reflective properties of vanadium dioxide are well recognised the stumbling block has been the switching temperature. It’s not much good if the material starts to reflect infrared light at 70 degrees Celsius. We’ve shown it’s possible to reduce the switching temperature to just above room temperature and manufacture it in a commercially viable way.”

Vanadium dioxide’s properties are based on its ability to alternate between acting as a metal and semiconductor. The switch between reflecting or absorbing heat is accompanied by a small change in the structure of the material, where the arrangement of electrons changes. Vanadium-vanadium bonds are stable below the transition temperature, which ‘lock’ the electrons and prevent conduction. Above the transition temperature these vanadium-vanadium bonds break and the electrons are free to conduct electricity making the material metallic.

Previous attempts to lower the switching temperature have incorporated low levels of elements such as tungsten, molybdenum, niobium and fluorine. These lower the transition temperature by supplying electrons into the material, which makes the metallic structure more stable.

By varying levels of tungsten the researchers were able to show that the optimum concentration was 1.9 per cent, but to make the coating cheaper to manufacture a method of laying down the coating during glass manufacture was necessary.

Dr Troy Manning (1), of UCL’s Department of Chemistry and lead author of the study, explains:

“For the glass manufacturing industry one of the most important coating methods is Atmospheric Pressure Chemical Vapour Deposition

(APCVD) because it allows the film to be deposited during the float-glass manufacturing process and is performed at atmospheric pressure so no high cost vacuum systems are required. The films grow at such a fast rate, which makes the process ideally suited for such a high throughput manufacturing process and the glass comes off the production line already coated without the need for any additional processes.

“Other thin film deposition processes such as physical vapour deposition (PVD) and sol-gel spin coating are performed after the glass is made and require additional expensive equipment such as vacuum systems for PVD or a spin coater capable of holding large areas of glass.”

Professor Parkin added: “The next step in getting the coating to market is to investigate how durable it is. Ideally, because it’s laid down at the point of manufacture you want it to last for the life time of the window but looking round you see many windows that date from the Victorian era, so we need the coating to last for over 100 years.

“Another consideration, is the colour of the coating. At present it’s yellow/green, which really isn’t attractive for windows. So we’re now looking into colour suppression as a way round this.”

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(1) Dr Manning is now based at the University of Liverpool

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