New materials with photonic crystals that filter radiation designed

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Research by the NUP/UPNA-Public University of Navarre has proposed various designs for photonic crystal materials that can be used to filter radiation. Specifically, the focus has been to develop a coating comprising dielectric spheres that, applied to a window, would prevent outside heat from entering in the summer and the indoor heat from escaping in winter.

The samples designed and the results obtained suggest a means for developing the right technique to obtain materials of this type in the future, although the outcome of the tests, which were carried out using low-cost, traditional techniques, were not what had been expected. This is according to a Ph.D. thesis by Paola Morales titled "Efectos de filtrado por recubrimiento de cristal fotónico" (Effects of filtering using photonic crystal coating) read at the NUP/UPNA.

Photonic crystals are materials with repeating structures and that have specific radiation-filtering characteristics, among other properties. Materials of this type exist naturally, as in the wing structure of Morpho menelaus butterflies, the skin of chameleons and precious stones such as opals. "Butterflies have a structure that interacts with light. For example, the blue butterfly has no blue pigments but adopts this colour whenever its structure interacts with the light," said Dr. Morales.

Morales' research was based on the use of spheres to create a photonic crystal coating with a filtering effect. The first part of her thesis focused on the analysis of the behaviour of the spheres with varied distances,

orders and shapes. "I used marbles and decorative gemstones with a diameter of a few centimetres to take the place of spheres and spheroids, respectively, with microwave radiation. These tests were compared with models carried out via computer and the coincidence was found to be very good. This has enabled us to design filters for visible infrared," said the researcher.

Low-cost manufacturing processes

The second part of the thesis consisted of trying to manufacture the materials and create a monolayer of spheres that would filter visible and infrared radiation. To cut costs, the researcher used spheres of three different types of materials, including titanium dioxide, an economic material that has high dielectric permittivity. "It is the material that, for example, is a component of chewing gum and toothpaste, and it is cost-effective. But the problem is that when the spheres are small, they get stuck to each other. What we are proposing is to create a coating using spheres with gaps. However, we did not manage to disperse them."

The materials obtained were, however, useful in verifying the filtering effect, but the researcher acknowledges that they did not obtain the desired decompressed monolayers, either. "Our plan was to design a colourless monolayer with total visibility, and a filtering effect. In most cases, current coatings tend to be made up of layers. In sunglasses, for example, a fairly thick pigmented film is applied to achieve filtering. If we were to apply a monolayer, we would need a much smaller quantity of material, but the effect would be the same."

Although the results of the manufacturing cannot be regarded as successful, the study of the tests and the detailed characterisation of the samples obtained are opening the door to future development of a suitable technique to obtain materials of this type.

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