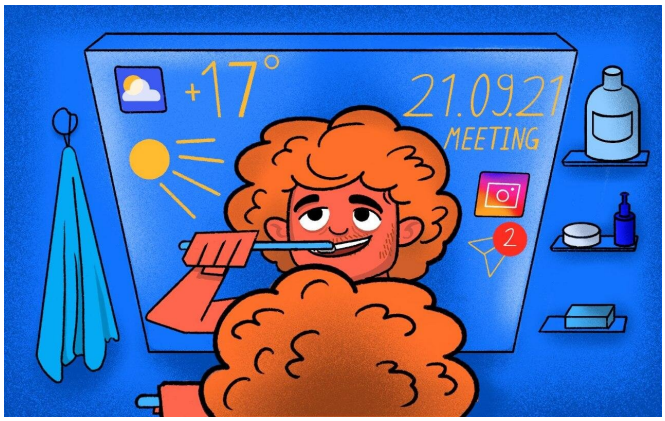
Researchers find a way to turn glass into smart surfaces

9 November 2020, by Itmo University



The innovative solution of the researchers is a thin film based on halide perovskites, semiconductor materials with extraordinary optical and electronic properties. Credit: Dmitry Lisovsky

ITMO researchers have created a surface that can turn normal glass into a smart surface. This technology can be used in the production of AR screens that equip users with additional information about what is happening around. The surface will also be able to convert solar energy into electricity. The research has been published in *Laser & Photonics Reviews.*

The innovative solution of the researchers is a thin film based on halide perovskites, semiconductor materials with extraordinary optical and electronic properties. These films are affordable to produce, they are used to create LEDs and solar cells with efficiency factors exceeding traditional technologies. The perovskites used in the project can transmit around a half of the light distinguished by the human eye. However, they reflect too much light which negatively affects their transparency.

"Perovskite films are successfully implemented in LED production. We want to use these films to create surfaces that could be potentially used in AR screens. They have to be transparent enough for users to be comfortable looking through them. At the same time, they have to radiate light to display the necessary information on the screen," explains Sergey Makarov, lead researcher at ITMO's Faculty of Physics and Engineering.

Originally, perovskite films have a reflection coefficient of 30%, which means that they do not transmit around a third of the light that enters them. Researchers from ITMO's Faculty of Physics and Engineering with their collaborators from the St. Petersburg National Research Academic University of the Russian Academy of Sciences have created a surface that transmits as much light as possible without reflecting almost any of it. It was also crucial to preserve the film's useful properties so that the users looking through them would not feel like there is a barrier in front of their eyes.

To lower the reflection coefficient, the researchers had to modify the films and turn them into a metasurface. They had to remove a layer of perovskite from the film to etch a certain pattern of nanoparticles on it. That way, the surface interacts with light differently. The pattern was created with nanometer precision using ion nanolithography.

"When our colleagues applied these methods to create nanostructures, they noticed that the exposed areas of metasurfaces became dark and burnt out. Even though a lot of the material was left, it did not luminesce under ultraviolet excitation. To solve this problem we applied the alcohol salt solution vapor to the perovskite surface, which allowed us to quickly restore the material's properties. For example, we increased its luminescence and lowered its reflection coefficient by means of this method," explains Tatiana Liashenko, a Ph.D. student at the Faculty of Physics and Engineering.

According to Kseniia Baryshnikova, the first author of the paper, the researchers were able to

determine the geometric parameters under which perovskite nanoparticles can interact with light in a broad range of the solar spectrum.

"Thus, most of the energy follows the direction of light. The rest of it is absorbed by the perovskite and transformed into photoluminescence. As a result, we get a highly transparent anti-reflective metasurface with active properties. We are now planning to implement our solution into optoelectronic devices," concludes Baryshnikova.

More information: Kseniia Baryshnikova et al. Broadband Antireflection with Halide Perovskite Metasurfaces, *Laser & Photonics Reviews* (2020). DOI: 10.1002/lpor.202000338

Provided by ITMO University