Light-emitting glass to enhance solar panel efficiency

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Credit: ITMO University

Researchers from ITMO University have developed optical luminescent glass that emits visible light under ultraviolet radiation. Due to this property, the new material has applications for increasing the efficiency and lifetime of solar cells. Ultraviolet radiation, which normally negatively affects solar cells, will be converted and used for extra charging of the cells. The glass is easy to manufacture and can also be used to increase the lifetime of white LEDs and ensure better color rendering. The study was published in the *Journal of Luminescence*.

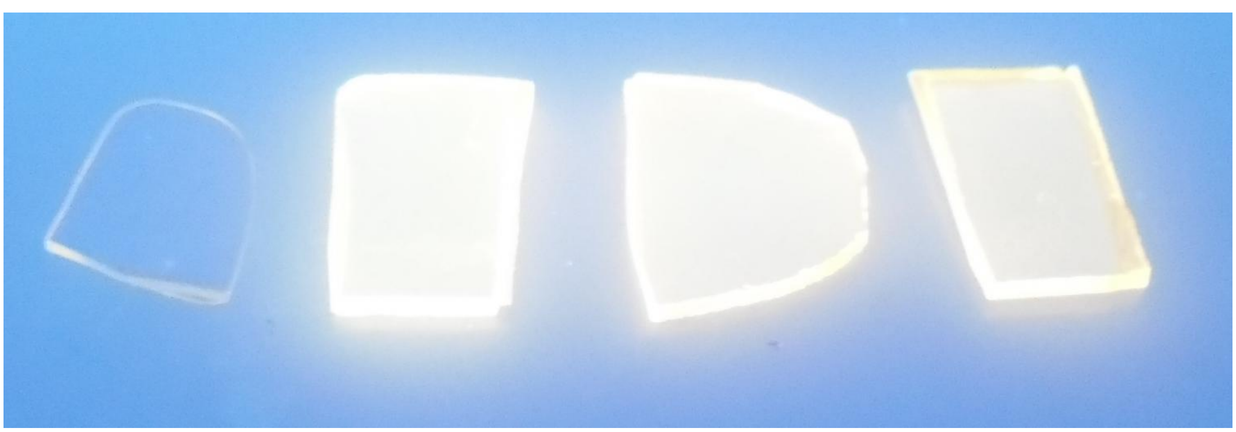
Ultraviolet light and dust reduce the performance of silicon solar cells. To protect cells against these negative factors, special glass screens are used. If the panel is covered with luminescent glass that emits light upon absorbing ultraviolet radiation, it will not only protect cells from mechanical impurities, but also significantly improve energy production.

Developed in the International Laboratory of Modern Photonic Materials and Technologies at ITMO University, this optical material absorbs ultraviolet radiation and converts it into visible light. Therefore, instead of damaging the solar panel, the energy of ultraviolet light can be used to charge it. The quantity of the "right" light falling onto the battery increases, thus increasing the battery's coefficient of performance.

Currently, the efficiency of solar cells is as low as around 20 percent, but could be greatly enhanced with the use of luminescent protective glass that has higher light conversion. "We have managed to increase the efficiency of ultraviolet conversion in the glass up to 30 percent, which is comparable with the front-end research in this field. We are already optimizing the technology and planning to raise the quantum yield twice. The glass with such properties can find solid application," says lead author of the research work, associate at the International laboratory of Modern Photonic Materials and Technologies Yevgeniy Sgibnev.

The scientists also suggest that production of the white LEDs with new luminescent glass will be a major step forward in the manufacturing methods of light equipment. Today, in order to obtain white light, the manufacturers perform a little trickery. They coat a blue LED with yellow phosphor—a polymer coating filled with emitting particles. Colors become mixed and give almost white light. However, in such devices, the color rendering is distorted. In addition, the phosphor layer quickly wears out since LEDs frequently overheat, destroying the polymer.

On the other hand, glass can withstand high temperatures and adverse weather conditions. Thanks to a special technology used by the scientists, the luminescent particles are embedded directly into the glass, providing better color rendering and durability of the material. "Such lighting devices made with luminescent glass can be installed in stadiums, highways, airports, concert halls. Now the LEDs require replacement every six months, but produced by our technology, they last 10 times longer; this will significantly cut the costs of lighting replacement," says Nikolay Nikonorov, chair of Optoinformatic Technologies and Materials at ITMO University.



Left glass contains no cerium. In the other glasses, cerium concentration increases from left to right. It is shown that the optimum content of cerium should not be high and provides maximum luminosity. Credit: ITMO University

The advantage of the new material is also in its simplicity. The glass is produced at 1500° Celsius and then shaped. In order to make the glass emit light from ultraviolet radiation, it is necessary to introduce silver ions in it and combine them into clusters of certain size. Therefore, the next stage is ion exchange: The glass is immersed in a molten silver salt at 320° Celsius, and the silver ions become embedded into the glass, replacing sodium ions. This method helps achieve high concentration of luminescent silver clusters inside the surface layer of the glass. The same technology of ion exchange is widely used to manufacture toughened glass for smartphones (for example, the well-known Corning Gorilla Glass) or for strengthening of champagne bottles. But instead of silver, these applications rely on potassium ions.

The last step of obtaining luminescent glass is heat treatment. Silver ions must be organized in clusters of exact size. The glass surface emits intense visible light only if the clusters include two to four silver atoms. Larger clusters may not have luminescent properties or else emit infrared light, which can be used to charge only specific types of solar cells. The clustering process is quite difficult to control, which is why luminous protective screens and solar panels should be developed together.

More information: Y.M. Sgibnev et al. Luminescence of silver clusters in ion-exchanged cerium-doped photo-thermo-refractive glasses, *Journal of Luminescence* (2016). DOI: 10.1016/j.jlumin.2016.04.001

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