When science brings light: scientists propose producing LEDs without rare earth metals

An international team of scientists synthesized and studied a compound that will help significantly reduce the cost of manufacturing LEDs to produce white light that imitates sunlight. Such diodes are widely used in lighting residential and industrial premises, for outdoor advertising and plant cultivation by agricultural enterprises.

The new compound belongs to the metal halide family — diodes made on its basis will be much cheaper than those produced using valuable rare-earth metals. The resistance to high temperatures and high "luminosity" of these diodes, achieved due to the enhanced quantum recoil, has been noted. The main results of the study were published in the reputable journal Angewandte Chemie — International Edition.

In the modern world there is an urgent need for cheap and energy-efficient LEDs with a good color rendering index. This is especially true for the BRICS countries, where the processes of industrialization and urbanization are very fast and the need for available energy is increasing daily. The problem of creating pure white radiation, which is organically perceived by plants and does not irritate the human eye, is more relevant than ever. Most modern solutions involve the use of rare-earth elements in the design of WLEDs. However, this resource is expensive, as well as gradually depleted and irreplaceable.

> *'We turned to metal halide compounds as a cheaper and more affordable alternative. They recorded many cases of luminescence from exciton states (this is a special electronic excitation in the material). Typically, luminescence occurs during transitions of electrons between different energy levels of atoms, and in practice rare earth elements are used, which are expensive and can end in the foreseeable future. Excitons, on the other hand, form in many compounds and do so without the participation of rare earth elements. In fact, working with these "democratic" compounds in terms of cost and distribution, we can significantly reduce the cost of production of luminescent materials and flood developing countries with inexpensive but high-quality LEDs. First of all, we are talking about China which produces most of the goods exported to other countries of the world including agricultural products which need round-the-clock good lighting similar to sunlight,'* said **Maxim Molokeev**, the assistant professor of the Department of Solid State Physics and Nanotechnology of Siberian Federal University, a senior researcher at Kirensky Institute of Physics of Siberian Branch of the Russian Academy of Sciences.

The scientist explained that (C9NH20) 9 [Pb3Br11] (MnBr4)2 synthesized by his Chinese colleagues had been previously obtained as a single crystal by another scientific group. But here's the bad luck, as the predecessors failed to correctly decipher the structure created in the laboratory. The researchers from Guangzhou, Krasnoyarsk, Zurich and Dubendorf have been the first in the world to propose the correct structure of the new material, also studying the issue of radiation, which is obtained in a rather unusual way, i.e. with the help of already mentioned exciton states.

> *'I can highlight several bright advantages of the new material: it stably tolerates high temperatures and when we irradiate it with ultraviolet radiation we get a very high-quality*

and powerful flow of quanta at the output. This material is "generous". For each watt of energy spent, we get an excellent amount of useful light (up to 90 lumens; for comparison incandescent lamps give 4-15 lumens per watt),' **Maksim Molokeev** pinned down.

Scientists have discovered the principle of the new compound: organic molecules form a non-conductive (dielectric) layer between the polyhedra containing the metal (low-cost, available lead or zinc). The dielectric layer provokes the formation of excitons on metal polyhedra. The result of removing these excitations is radiation in the visible spectrum, for the sake of which everything was conceived.

The trend for the development of materials that do not use rare earth elements was born in China which is interested in preserving its natural resources. Almost all modern luminaires (both mercury and LED) use expensive rare-earth metals which means it is important to try and collect a luminescent layer of lamps, using simple chemical elements that will not deplete in the coming centuries.

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