MEPhI scientists find way to raise energy efficiency of lighting facilities

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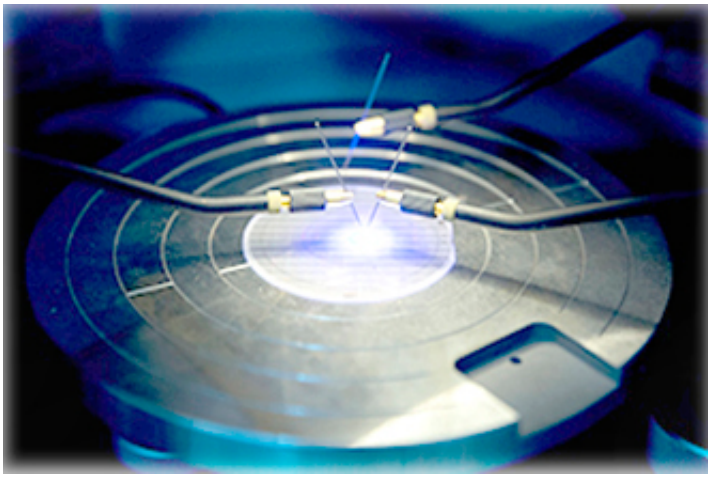

Credit: National Research Nuclear University

Energy efficiency and energy savings are the first among five new priority directions of Russia's innovative development. One of methods, which can raise the efficiency of electric power use, is incandescent lamp replacement for more energy-conserving lighting facilities—for example, solid-state light sources.

Solid-state light sources economically use energy in comparison with preceding generations of electric light sources like arc lamps, incandescent and discharge lamps. The elementary unit of modern solid body lighting systems is the white light-emitting diode – it is usually a "blue" chip, covered with a layer of amber phosphor, which "absorbs" a

part of blue radiation and re-irradiates it in the amber field of the spectrum.

In LED production, several chips are mounted on a special card. Chip-setting can be conducted in two ways: online editing and the so-called flip-chip method. The gist of the flip-chip process is the connection of the semiconductor structure with the carrier active side down.

The perfection of solid-state light sources is impossible without the development of effective LEDs. One of the main problems in the creation of high-radiance LEDs is the low coefficient of the light output from crystal. Due to the big difference in the refraction index value according to the Snell law of refraction, the significant part the generated radiation is reflected inside, and only a small part penetrates to the outside.

Application of base coats from silicon carbide SiC with a high refraction index close to that of GaN, eliminates the total internal reflection phenomenon at the semiconductor-baseplate borderline because of suppression of the waveguide effect. Currently, the most effective way to overcome this problem is the creation of light-dissipating surfaces.

The aim of work, conducted by MEPhI "Nanotechnologies" Centre, was the pattern formation at the surface of silicon carbide by the plasma-chemical etching method for enhancement of external quantum efficiency of blue light-emitting diodes on the basis of InGaN/GaN heterostructures.

In the dry etching process, the bottom side of the base coat 4H-SiC was covered with micro- and nanorelief with a netty form texture. The sizes of the texture elements varied from 3.3 square um at a distance of 2 um between them. Measuring of the light output power showed a 1.5-2 times higher light efficiency in comparison with LEDs. What's more, the light

efficiency depends on sizes of inhomogeneities, and LEDs, having texture elements of 400 to 500 um in size are characterized by the highest quantum output. It is qualitatively explained not only by light-diffused scattering at the obtained nanorelief but also by forming cut zones for radiation diffusion along the surface.

"The developed technology of getting SiC relief surface can be used in conditions of flip-chip LED production. Its incorporation will significantly raise energy efficiency of Russian light devices," said one of project participants, MEPhI IFNE Deputy Director Alexander Gusev.

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