Switchable two-color light source on a silicon chip

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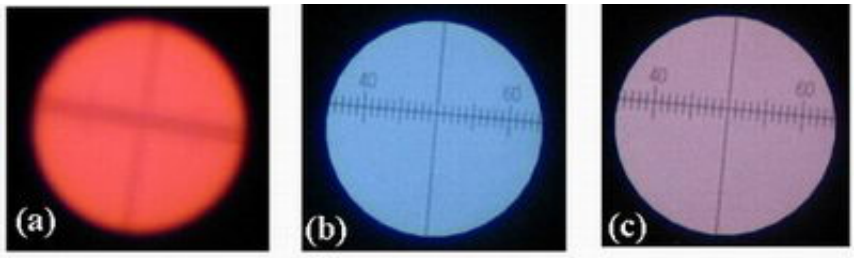

Photographs of the multi-color light emitter, 200 micrometer in diameter, taken under a microscope: the electrical current was 0.02 mA (a), 1 mA (b) and 2.5 mA (c), respectively. The violet color in (c) is a result of mixing the red and the blue.

Silicon is the most important material for electronic chips and processors. Yet it has a big drawback: being a so-called indirect semiconductor, it hardly emits any light. Therefore worldwide efforts in the labs of the microelectronics industry are aimed towards developing more efficient light sources based on silicon.

Physicists at the Forschungszentrum Dresden-Rossendorf (FZD), Germany, now managed to make silicon shine red and blue in an alternating fashion. This two-color light source could help to produce cheap and compact biosensors. Recently a patent was filed related to this discovery.

It is not an easy task to make silicon shine, or, more accurately, to generate electroluminescence from this material, since in its usual form it can only emit with a very low efficiency. The Forschungszentrum Dresden-Rossendorf has worked successfully for several years on the realization of silicon based light emitters. Initially the physicists made a blue-violet emitter, which was then the basis of a silicon based optocoupler.

In 2004 they demonstrated ultraviolet, and then green light emitters. Now the physicists can switch the characteristics of the emitted light between two colors – red and blue – at will, depending only on the electrical current flowing through the device. The compatibility of these emitters with standard Silicon microelectronic technology is crucial, since the two-color nano-switch could easily integrated into common Silicon chips.

For the fabrication of the test devices the group around Dr. Wolfgang Skorupa deposits an only 100 nanometer thin insulating silicon dioxide layer on the surface of the silicon wafer. Then the element Europium, which belongs to the group of rare-earth elements, is implanted using a beam of fast, charged atoms (ion beam).

The peculiarity of Europium lies in the fact that it forms two different types of impurities carrying a different charge (oxidation state). These are the origin of the red and blue luminescence. Depending on the strength of the electrical current one or the other impurity type is excited to emit photons.

Possible applications of this two-color device lie in the area of biosensing. For example, the new silicon based light source could be used in the fast and cost-effective point-of-care analysis in health and environmental protection.

Citation: S. Prucnal, W. Skorupa, J. M. Sun, M. Helm, Switchable two-color electroluminescence based on a Si metal-oxide-semiconductor structure doped with Eu, *Applied Physics Letters* 90, 181121 (2007).

Source: Forschungszentrum Dresden-Rossendorf