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Sulfur Bulb Lamp May Displace RE Phosphor Lamp

A breakthrough in lighting was announced by the U.S. Department of Energy (DOE). This revolutionary lighting device consists of a quartz sphere (about 4 cm [1.5 inch] in diameter) filled with an inert gas and a small amount of sulfur. When the sulfur is irradiated by microwaves, it emits a large amount of light, as much as 250 standard 100-watt incandescent bulbs. The new light, which was built by Fusion Lighting of Rockville, Maryland, is being tested at DOE's head-quarters and at the National Air and Space Museum in Washington, DC. Two of the sulfur bulb lights are being used to replace 240 conventional high-intensity mercury discharge lamps of 200 watts each. The light is channeled through a parabolic reflector into a plastic "light pipe". The light pipe is 25 cm (10 inches) in diameter and 72 m (240 feet) long, and was invented by A. L. Whitehead of Vancouver, Canada and built by 3M. The new system produces three times as much light, while using only 25% as much energy as the mercury lamps. Since there is no filament or electrode, the sulfur bulb lamp may last many years. The installation costs were reported to be less than half of those for upgrading a conventional lighting system. The major disadvantage reported by those who have seen the new lamp is the hum caused by the microwave generator.

DOE claims that the new sulfur bulbs would be ideal for lighting large interior spaces, such as factories, warehouses, shopping malls, and arenas. These new lamps are also expected to work well for outdoor lighting. If the initial claims for the new sulfur bulb lamps are even half correct, they could have a significant impact on the use of rare earth materials (phosphors) in the lighting industry. The impact, however, would not be felt much before the end of the 20th century.

New Family of Rare Earth Superconductors

An international team of scientists headed by R. J. Cava (AT&T Bell Laboratories, Murray Hill, New Jersey and co-workers from Delft, The Netherlands and Tokyo, Japan) reported on the existence of a new family of quaternary superconductors, **Nature 372**, 245-247 (17 November 1994). These new compounds are closely related to the lanthanum-nickel-borocarbide superconductors, which were discovered about a year earlier [see **RIC Insight 7** [3] (March 1, 1994)]. The new material is a boronitride having the composition $La_3Ni_2B_2N_3$. Its superconducting transition temperature is a respectable 12K. This new phase is prepared by arc-melting lanthanum, nickel and boron in a nitrogen gas-filled chamber. The crystal structure of $La_3Ni_2B_2N_3$ is related to the $LuNi_2B_2C$ superconductor, but the former consists of three rock-salt-type LaN layers alternating with tetrahedral Ni_2B_2 layers. This layered structure is considerably more two-dimensional than is observed in the superconducting borocarbides. The boronitride is somewhat sensitive to the exposure of moisture in the air, but limited handling in air was not a problem.

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As the authors noted the discovery of superconductivity in $La_3Ni_2B_2N_3$ demonstrates the existence of superconductivity in layered materials based on the stacking of Ni_2B_2 tetragonal layers with single (as in $LuNi_2B_2C$) or triple (as in $La_3Ni_2B_2N_3$) MX rock-salt-type layers. This strongly suggests that Ni_2B_2 layers are important building blocks for high temperature intermetallic superconductivity, similar to the role played by the CuO_2 layers in high temperature oxide superconductors. The authors state that: "These discoveries strongly suggest that a large number of unusual superconducting intermetallic phases are yet to be found, based on materials more complex that have previously been considered as candidates for superconductivity."

Room Temperature Tb^{3+} Emission

Although the first Tb^{3+} emission at room temperature was reported about 20 years ago in TbP_5O_{14}, no one had been able to find another stoichiometric Tb ion compound in which the Tb^{3+} emission was not quenched at room temperature until recently. In addition large TbP_5O_{14} crystals of good quality were difficult to obtain. But recently M. Sekita and co-workers (National Institute for Research in Inorganic Materials, Ibaraki, Japan) reported that they were able to grow large single crystals of $TbAlO_3$ which gave a strong Tb^{3+} emission at room temperature [**Appl. Phys. Lett. 65**, 2380-2382 (7 November 1994)]. The high quality $TbAlO_3$ crystals were grown by using the Czochralski method in a reducing atmosphere. If grown in an inert atmosphere, the sample contained Tb^{4+} which causes the crystal to turn black. This new material has the potential to be used as a visible four-level laser system. However, to date the authors were unable to obtain any laser action, but they plan to continue their studies and experiments to try and show laser oscillations in $TbAlO_3$.

ErGe Photoconductive Detector

The doping of erbium into semiconductors and insulating glasses has many important technological applications because of the 1.54μm luminescence emitted by the Er^{3+} ion. This wavelength is close to the maximum transmission of the optical fibers used in optical communications. In addition, because of the large gains shown by erbium-based fiber amplifiers, a great deal of effort is being made to study the spectroscopy of erbium in both silicon and germanium semiconductors and strained layer superlattices formed by silicon and germanium. One of the problems is that germanium absorbs radiation wavelength shorter than 1.6μm, and thus the Er^{3+} ion emission cannot be studied directly. But other studies can be fruitful. In one such international study, H. Navarro (Instituto de Investigación en Comunicacións Optica, Universidad Autónoma de San Luis Potosí, Mexico) and co-workers (from Hamilton and Ottawa, Canada) applied the photo thermal ionization spectroscopy technique to study the behavior of an erbium-doped p-type germanium epitaxial layer on an undoped n-type germanium substrate (**Appl. Phys. A 59**, 373-379 (1994)]. The erbium-doped germanium layer, which was grown by a molecular beam epitaxy technique, showed a continuous photoconductivity response in the far-infrared region from 70 to 900 cm^{-1} (143 to 11μm). The authors concluded that erbium-doped germanium could be used as a broad-band photoconductive detector that covers, with one device, the broad spectral region between 10 and 140μm.

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