The Luminescence and Display Division (LDM) of The Electrochemical Society

by T. F. Soules

Luminescence, the emission of light by a material after it has been exposed to ultraviolet radiation (UV) radiation, electron bombardment, X-rays or some other method of excitation, has fascinated people since ancient times. Even as late as the early 1900s, Thomas Edison and E. L. Nichols concluded "unless someone discovers a means of making luminescent bodies that are vastly brighter than the best known now, luminescence may be excluded altogether as a factor in artificial lighting." However, in the mid-1930s a small group of innovative engineers at the General Electric Company (GE) coated linear incandescent lamp tubes with a ground-up mineral phosphor, willemite, evacuted the tubes, dosed them with a small amount of mercury and filled them with a few torr of argon and sealed the ends with electrodes. In 1938 GE introduced the first commercial mercury fluorescent lamps. Today fluorescent lamps use synthetically made phosphors; due to their high efficiency, fluorescent lamps produce more light by far than all other lamp types.

Phosphors are also used in displays and other applications, so much so that they have become ubiquitous and are taken for granted in our modern society. You wake up in the morning and look at an alarm clock displaying the time using bright red gallium phosphide light emitting diodes (LEDs). If you live in Europe or Japan you probably turn on a compact fluorescent lamp (CFL) which contains rare-earth activated phosphors. When you start your car to go to work pale green light from zinc sulfide activated with manganese electro-luminescent (EL) display panels show the time, your radio channel and perhaps whether your seat belt is fastened or your car needs oil. In Japan the traffic lights may use gallium phosphide and indium gallium nitride LEDs. When you arrive at your office, it is illuminated with either ceiling panels containing linear fluorescent lamps producing light from calcium halophosphate phosphors, or CFLs, in recessed fixtures. The computer on

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your desk displays information from zinc sulfide phosphors excited by a high energy electron beam from a cathode ray tube (CRT). Your compact disc (CD) is read with a gallium arsenide infrared laser. At home, in the evening, you look at another CRT using phosphors, your television. Your children play with fluorescent crayons. When you put them to bed small stars pasted on the ceiling in the pattern of constellations continue to glow from long afterglow rare-earth activated phosphors after the light is turned off. Other uses of phosphors abound from X-ray screens and storage devices and large panel displays, to stamp and currency markings.

History and Scope of the LDM Division

In the 1930s a section of the new Electronics Division of the ECS was formed for those interested in luminescence. This was about the time when the systematic search for and development of synthetically-made phosphors began, spurred by the invention of the fluorescent lamp and the need for new phosphors for radar screens. Not surprisingly in the 1930s and 1940s, luminescence was perhaps the most active section in the new Electronics Division, although it was still small compared to the more traditional divisions of the ECS. In a single year, for example, 1949, there appeared in the **Journal** of the ECS: (1) a paper by Butler which characterized zinc beryllium silicate phosphors which made white fluorescent lamps possible; (2) Kroger described the zinc sulfide phosphors activated with silver and copper, which are the phosphors still used today in color television and display tubes; (3) Jenkins, McKeag and Randby presented a definitive characterization of the halophosphate phosphors which they discovered and which became the standard white emitting phosphors for fluorescent lamps, thankfully replacing the toxic berylium containing phosphors; and (4) a paper by Lowry presented mechanisms of phosphor degradation in lamps and how to fit the lumen maintenance over time, which is still often used. The list of authors contributing to the luminescence section of the **Journal** also included Klasens, Hoekstra, Cox, Fonda, Froelich, Lehman and many others, a veritable who's who of the early fathers of modern luminescence and synthetic phosphor development.

These papers also set the scope of the Luminescence section—announcing new phosphors, presenting their synthesis and characterization, how they were excited, the wavelengths they emitted with certain activators and the efficiency of the phosphors. Other papers dealt with applications of these phosphors. The physics and chemistry of luminescent materials and their applications became and still is the core area covered by Luminescence symposia.

In the 1950s and 1960s, with the invention of the transistor and the silicon chip, the Electronics Division grew rapidly while the Luminescence section remained roughly constant with many of its papers dealing with improvements in phosphors, such as, the halophosphates and television phosphors and their manufacture. In the 1960s the Luminescence section became its own group having its own officers, executive meeting and group luncheon. The group consisted mostly of people working in luminescence in the industries and plants which had sprung up to produce phosphors for lamps, displays and X-ray equipment. It was a close group of people, some of whom had worked in luminescence or related areas throughout their careers, and who had a strong loyalty to the Luminescence group.

In the 1970s when it was generally believed that phosphors were as efficient as possible, Verstegen et al. [*J. Electrochem. Soc.* **121**, 1623-7; **121**, 1627-31 (1974)] announced a new set of rare-earth activated aluminate compounds which improved both the color rendition and efficiency of fluorescent lamps and made CFLs possible. Also, greatly improved X-ray phosphors, X-ray storage devices and scintillation counters for computer-aided tomography became a reality. At the same time, the *Journal of Luminescence* (ICL) was formed and it attracted many of the more academic papers in the area of luminescence. Similarly the Society for Information Displays (SID) attracted those more interested in the application of phosphors in displays. Also several physics journals published most of the papers in the burgeoning field of lasers. The Luminescence group of the ECS continued to attract papers dealing with the physics and chemistry of phosphors and the group leaders including Struck, Peterson, Royce, and others began to expand the scope of interest of the group to other areas including non-linear optics and photonics. The most successful of these expansions were co-organized symposia on luminescent related topics with other ECS Divisions.

In 1991 the Luminescence group applied for full Division status in the ECS, which was granted in 1992. At this time the group was holding several successful symposia both in the area of the physics and chemistry of luminescence and in various luminescence applications. Luminescence was undergoing another renaissance with renewed interest in colored EL displays, other types of flat panel displays, X-ray phosphors, high definition and projection display phosphors, and the rare-earth fluorescent lamp phosphors.

Present and Future

Currently, the LDM Division is in a healthy state and serves well as a forum for papers in luminescence and related fields. Due to the efforts of its current leaders it is attracting workers and papers back from ICL and SID, bringing together all aspects of luminescence from theory to application.

The field of luminescence is also very active both in industry and in universities and it is on the verge of still another major revolution with the invention of high efficiency blue and UV gallium nitride LEDs by Nichia. These LEDs, which directly convert electrical energy into light, could in principle surpass the efficiency of fluorescent lamps and be used to make displays or lamps lasting much longer than current devices. The field of luminescence is bright indeed, (excusing the pun) for all of us.

In the future, the LDM Division also must serve as a forum for papers on LEDs and laser diodes. It must become more international as a good deal of work in luminescence is being done in Japan and Europe. It must also continue its recent efforts to hold symposia which will attract people from universities and serve as a forum for academic, as well as practical discoveries in the field of luminescence. Finally the LDM Division should become more integrated into the ECS as a whole and give back to the ECS by supplying active leadership to the organization. ■

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