What is Semiconductor Light Matrix (SLM) Technology?

Abstract
UV curing applications have been growing rapidly with at rates as high as 50% per year in some market segments. Growth rates are expected to continue at this rate due to productivity gains and environmental benefits associated with UV curing. While UV curing has been gaining market share and enabling new applications, new methods to produce UV light have been under development. This paper describes the latest technology for producing UV light, Semiconductor Light Matrix Technology (SLM) developed by Phoseon.

UV Light Sources Background

Forty years ago, mercury-based arc lamps were the only UV light source available to initiate the UV curing process. As shown in Figure 3, new bulb-based light sources such as Excimer bulbs, microwave sources have been introduced, but the basic technology remains the same. Phoseon Technology has developed a "bulbless" Semiconductor Light Matrix (SLM) technology to produce UV light for curing applications.

The future of high intensity UV technology is small, cool and clean, with no lamps.

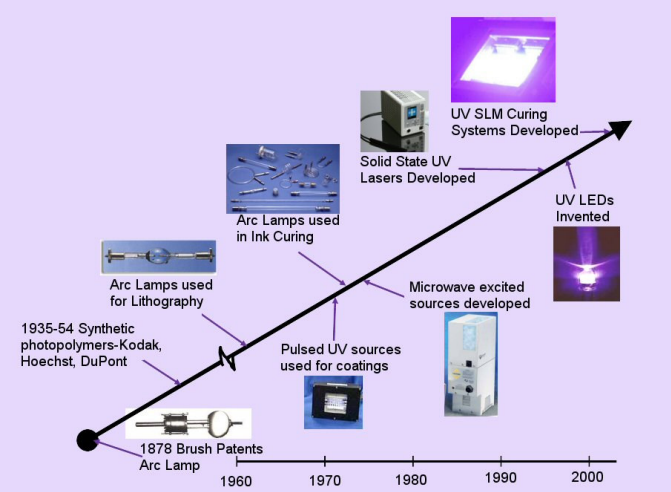

Figure 1. UV Light Source Technology Time Line

What are semiconductor based light sources?

The unique properties of semiconductors were first reported by Michael Faraday in 1883. Research into light sources based on semiconductor materials as not only an alternative to bulb based light sources but an enabling new technology began in the 1960's. The following gives a high level description of how semiconductors produce light.

Impurities or dopants are added to the base intrinsic semiconductor material to either add free electrons (n – negative) or create holes to attract electrons enabling current flow (p – positive) which results in an extrinsic semiconductor. When an external electric voltage bias is applied across the junction, current can be made to flow, and when the holes from the p-type and electrons from the n-type meet at the junction and combine a photon of light is released.

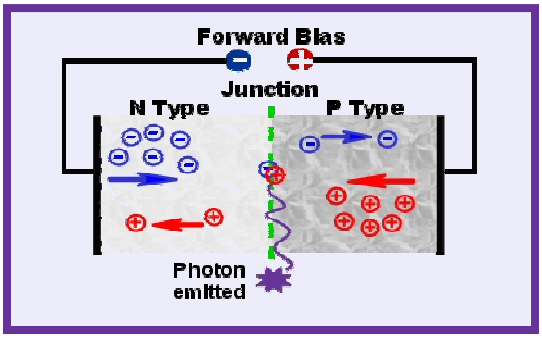

Figure 2. Semiconductor p-n regions

SLM Technology

Phoseon's Semiconductor Light Matrix (SLM) technology combines a dense array of light emitting semiconductor devices, with micro optics and advanced thermal technology in a cost-effective MOEMS (micro opto electro-mechanical system) package. The result is a high intensity UV light system that offers an efficient, scalable, safe, long-life, and environmentally friendly alternative to traditional UV sources.

UV light sources constructed with semiconductor based light emitting devices could be as simple as an array of packaged LEDs. However, the light produced by such an approach will be inherently limited by the existing package design.

Figure 3. Packaged LED

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A better approach to address industrial applications will be to customize the packaging, optics, and thermal design to optimize the output.

A single semiconductor die is the building block of SLM technology and is less than half a millimeter in size. The method used to attach the die to the substrate is critical as the junction temperature directly affects performance. Therefore, the design must allow for optimum thermal management. Phoseon has addressed this by designing an appropriate combination of substrate material, die attach method, and thermal technology.

Another design element that Phoseon has developed is the appropriate optics to capture and direct the light to the desired location. Light emitting semiconductor devices emit light over a wide angle. Therefore, optical techniques have been developed to capture the light and direct it to the work surface to increase irradiance.

The combination of these techniques is the heart of Semiconductor Light Matrix (SLM) technology. Phoseon is able to deliver higher irradiance, >1W/cm2, over longer life time, with lower cost of ownership.

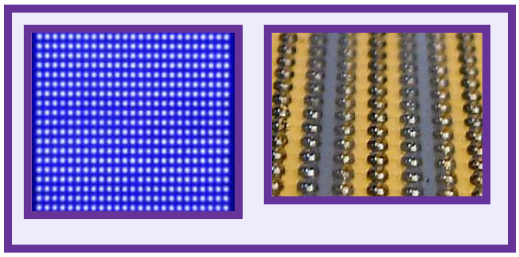

Figure 4. SLM Technology

New Source for UV Light

The transition from solvent based chemistries and drying ovens to UV based chemistries and bulbs brought desired energy savings and increased productivity, the next generation of UV light sources will enhance the use of UV curable materials even more by providing the following:

- Additional energy savings with one-fourth the energy needed for arc lamps
- Elimination of hazardous mercury and no ozone generation
- Increased productivity with instant on/off requiring no shutters and no warm-up time
- Ten times longer life with consistent output over lifetime of SLM
- SLM technology can be easily scaled to meet any application requirement in both width and length
- No added heat to substrate during curing

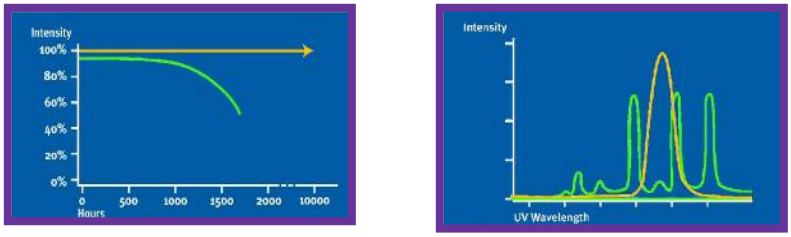

Figure 5. UV-Lamp vs. UV-SLM Comparison – Lifetime and Wavelength

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