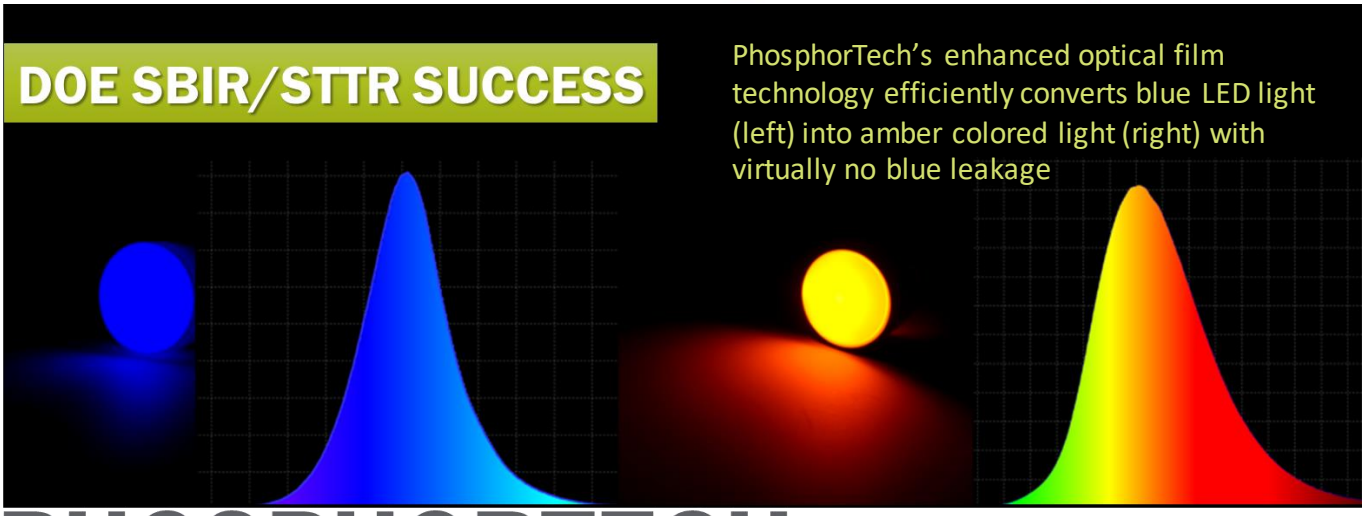
SBIR·STTR America's Seed Fund

U.S. DEPARTMENT OF ENERGY | SBIR/STTR Programs Office



PHOSPHORTECH

Although Solid-State Lighting (SSL) sources such as light-emitting diodes (LEDs) are much more energy efficient and versatile than legacy lighting technologies, including fluorescent lamps, the adoption of LEDs for lighting products is still very low due to their high cost and the monotone color of the light produced. Today, many commercial LEDs use phosphors to convert some of the violet/blue light to green/yellow/red light for a wide variety of indoor/outdoor applications. This includes not only general illumination for residential and commercial buildings but also other forms of lighting such as automotive, aerospace, street lighting, horticulture, even backlit displays used in portable electronics. However, phosphors are expensive optical materials that can range in price (per kilogram) from 1X to more than 10X that of silver. Producing a consistent high quality white or amber light from blue is especially challenging and typically involves using a large amount of phosphor materials, resulting in high costs.

FACTS

PHASE III SUCCESS
After two Phase II DOE SBIR awards, PhosphorTech attained $5.7M in product sales, service and licensing revenues.

IMPACT
The RadiantFlex™ film technology enables the production of high-demand warm white and amber color light in LED products, while at the same time reducing up to 50% the expensive phosphor material usage, resulting in high performance, cost-competitive LED products for many applications.

DOE PROGRAM/OFFICE
Solid-State Lighting (SSL)/ Energy Efficiency & Renewable Energy (EERE).

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PhosphorTech Corporation was launched in 1998, at the time when solid-state lighting technology was poised to evolve into a major challenger to traditional lighting methods. During that period, Japanese and other international companies were dominant players and held a strong intellectual property position on the phosphor material technologies used to produce white light from blue LEDs.

Supported by just a handful of SBIR awards from the Department of Energy (DOE) between 1999 and 2005, PhosphorTech developed and patented alternative phosphor materials and processing technologies that made it possible to produce white light from blue LEDs without paying multi-million dollar licensing and royalty fees to international corporations. The company offered its technologies to U.S. LED manufacturers through a series of partnerships and with minimal upfront costs. This business model was later emulated by other small U.S. phosphor material companies and enabled them to become strategic global industry players and increased U.S. competitiveness in solid-state lighting.

PhosphorTech's SBIR projects were funded by the Solid-State Lighting (SSL) Program within the Energy Efficiency& Renewable Energy (EERE) Office, under the supervision of DOE's Manager James Brodrick. The SBIR work focused on optimizing materials composition and developing low-cost film deposition techniques to apply conformal coatings of optical materials and phosphors on a wide variety of rigid substrates including LED wafers, glass, metal, and various optoelectronic device packages. The successes of initial material development and film deposition efforts were then leveraged along with new SBIR funding to develop high light extraction luminescent materials and film structures for next-generation solid-state lighting technologies. This culminated into one of PhosphorTech's most successful U.S.-manufactured products to date – the flexible phosphor film or RadiantFlex™.

PhosphorTech's enhanced light-converting films use a unique roll-based coating process to achieve superior performance while simultaneously reducing phosphor material usage between 33-50%, depending on the desired color temperature. The higher performance is a result of increased blue LED light absorption combined with reduced optical scattering losses because thinner phosphor layers are used within the color converting film technology.

Moreover, the phosphor films are compatible with a wide range of printing technologies – including 3D printing – that enable the production of hybrid light-emitting 3-dimensional optical structures never before possible. Using this approach, PhosphorTech developed a hybrid phosphor/nanocrystal structure with significantly improved performance for medium to high power lighting applications.

DOE funding was instrumental in many of these developments and commercialization of such technologies is currently underway in partnership with several U.S.-based clients that manufacture LED lamps and display backlights within the continental USA. The advancements completed during the performance of their Phase II SBIR grant entitled "Hybrid Down-Converting Structures for Solid State Lighting" are particularly relevant to the mission of the DOE's program to develop advanced, high performance, high efficiency and low cost down converting materials compatible with evolving general illumination markets worldwide.

All of the company's phosphor films are produced in Kennesaw, Georgia and shipped to domestic and international customers. Light converting films are used today by several industry-leading LED and lamp manufacturers in production of more than 20,000 LED parts annually.

The RadiantFlex™ film technology enables the production of warm white and amber color with 50% less material. This innovation was instrumental in making U.S.-based manufacturing of LED products competitive with foreign imports and legacy lamps. The price competitiveness and high performance of RadiantFlex™ films creates new markets such as studio lighting where color quality and consistency are paramount. It is now possible for studio lighting luminaire designers to produce customized lamps with specific color temperatures (CCTs) and high color rendition (CRI) that exceed the Television Lighting Consistency Index (TLCI) requirement. As a result, the demand for PhosphorTech's color-conversion films is projected to increase significantly in a few years by 100,000 parts/year.

Beginning in 2004, PTC has received four SBIR grants including two Phase I and two Phase II awards representing a total income of $2.5M. As of November 2018 PhosphorTech has received a total of $5.7M in product sales, service and licensing revenues. About half of the revenue to date is from sales of RadianFlex™ products that are made at their facility in Kennesaw Georgia. These products are typically developed in close collaboration with the customer for a specific level of performance such as specialized theatrical or broadcast lighting. Sometimes contract sales are negotiated for special design and development services with current and future customers for unique or prototype down converter systems for applications ranging from vehicle lighting to general illumination. These projects are considered a PhosphorTech service and are paid by the customer who is usually a domestic firm, but some work has been purchased by manufactures of general illumination and display products incorporated in other countries. There are also licensing agreements producing royalties with a few manufacturers who manufacture unique products derived from RadianFlex™ intellectual property included in this total. This source of revenue is expected to grow significantly during the next few years as more commercially attractive solutions are developed at PhosphorTech.