Composition and Supply Chain Considerations of White Lighting-Class LEDs

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Blue or near-UV LEDs are created through the deposition of InGaN thin films on SiC or AlO_3 (sapphire) substrates. Down-conversion from monochromatic blue or near-UV light to polychromatic white light is normally accomplished via a deposited phosphor system.

Small amounts of highly purified elemental materials are used in the fabrication of LED and other semiconductor devices. Nitrogen and Oxygen come from the air. Silicon and Carbon come from sand. Aluminum is a ubiquitously mined mineral. To the extent that any of the materials used in LED fabrication are rare or exotic, Gallium[(1)], Indium[(2)], and the phosphor are worth some further discussion:

Gallium and Indium metals are found in nature as trace elements in zinc, coal, bauxite, and other ore deposits, and refined to a pure state for usage in LED manufacturing as well as other industries (LCD displays, mirror manufacturing, lubricants, biomedical, photovoltaic, many others; see links below). Ga and In can be delivered in metallic form, or as a precursor gas in a metal canister the size of a beer can. A single canister is quite expensive, but lasts for months in normal LED manufacturing due to the small amounts of the material required. The sources for Ga and In are "plentiful in the earth's crust and widely distributed geographically and politically[(3)]", and the supply of purified In and Ga metals and precursors are "limited only by facilities investment and capacities[(3)]".

The phosphor materials used in LED manufacturing vary in chemical composition from application-to-application and LED manufacturer-to-manufacturer, but are generally provided as a stable, low toxicity, rare earth[(4)] powder, and are available from multiple suppliers worldwide. Suppliers of LED phosphors generally also produce mass quantities of similar phosphor materials for applications in television CRTs, instrumentation, as well as conventional lighting (e.g. fluorescent). Due to the very small light-emitting source size, LEDs consume small quantities of these materials relative to CRTs and conventional fluorescent lamps. It is reasonable to expect that supply and demand forces will continue to make these materials readily available in the marketplace as older technologies like CRTs ramp down in volume and LEDs ramp upwards.

The finish LED product – in the case of Cree, the XLamp® LED – is RoHS compliant and "Article Exempt" from a TSCA standpoint. By definition, article exemption means:

"…a manufactured item: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which does not release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use."

In summary, white lighting-class LEDs like the Cree XLamp LED do not contain any particularly difficult to obtain or hazardous elements or compounds. XLamp LEDs are RoHS compliant, and Article Exempt per the U.S. Environmental Protection Agency's Toxic Substance Control Act definition.

(1) More info on Gallium: http://en.wikipedia.org/wiki/Gallium
(2) More info on Indium: http://en.wikipedia.org/wiki/Indium
(3) More info on Ga & In supply: INDIUM AND GALLIUM SUPPLY SUSTAINABILITY; Gregory Phipps, Claire Mikolajczak, Terry Guckes Indium Corporation; 22nd EU PV Solar Conference, Milan Italy 4Sep07, p.5-6 http://www.indium.com/_dynamo/download.php?docid=552.
(4) More on rare earth elements: http://en.wikipedia.org/wiki/Rare_earth_element