DIRECT DETERMINATION OF DOPING LEVEL IN PHOSPHOR MATERIALS FROM X-RAY SIGNAL INTENSITY RATIOS

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Doping certain crystalline host materials with small amounts of an activator element, generally a transition metal or a rare earth, creates phosphor materials, which are employed in a wide range of applications. Examples include Mn-doped Zn_2SiO_4, Ce- or Tb- doped $LaPO_4$, Eu-doped Y_2O_3, Eu-doped $BaMgAl_{10}O_{17}$, Pr-doped YF_3, and Cu-doped ZnS. In most phosphor materials, a key performance factor is the atomic ratio of one host matrix element to the dopant element used. This presentation describes a method for direct determination of this host:dopant atomic ratio from observed X-ray signal intensity ratios measured by energy dispersive X-ray fluorescence spectrometry applied to a specific host:dopant pair.

At Cabot Superior MicroPowders, phosphor powders are produced from liquid precursors using proprietary spray pyrolysis methods. This EDXRF method is used primarily as a quality control check to ensure the proper doping level in the liquid precursor. It is also applied to solid phosphor materials after acid digestion to obtain a liquid sample for presentation to the spectrometer.

A key factor, which must be carefully controlled, is the concentration of the host element in the solution to be analyzed – this host element concentration must remain at a fixed level due to the complex relationship between observed signal intensity ratio and dilution factor for a given host:dopant atomic ratio. In the specific system studied, the dopant element is an absorber for host element radiation.

This EDXRF method is highly suitable for a production environment due to instrument compactness and minimal services required as compared with other methods for determination such as ICPOES.