

研 究 主 論 文 抄 録

論文題目 Processing of zinc sulfide based phosphor in two methods: TNT thermal processing in a containment vessel and hot double cylinder implosion
(容器中での TNT の加熱プロセスおよび高温二重円筒爆発圧搾法による ZnS 基蛍光体の処理)

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主論文要旨

Electroluminescent, EL, materials are of interest in providing high brightness for display screens found in portable electronic devices where the battery life is limited. Currently organic luminescent materials are being used, but the lifetime is low due to the degradation of the organic material under electric field over time. Inorganic phosphors are not susceptible to the same thermal degradation that organic phosphors are. An inorganic phosphor, primarily zinc sulfide, was treated by TNT or explosively driven shock loading in two different types of experiments

The processing of zinc sulfide (ZnS) phosphors with TNT was accomplished by heating the ZnS Phosphor precursor mixtures to a high temperature to create the necessary defect and doping structure for luminescent performance. From a patent application, a high brightness, long lifetime electroluminescent material was produced by heating a ZnS phosphor mixture supporting some TNT powder until the TNT exploded in an evacuated vessel. The work in this thesis shows that TNT does not detonate, but will deflagrate in a small but unconfined space in an evacuated vessel at about 295°C, TNT's boiling point; placing the TNT above the ZnS phosphor mixture will produce a phosphor with good luminescent properties.

First, the TNT was placed on top of the precursor powder and the vessel was closed and evacuated. Heat was applied to the TNT and ZnS phosphor mix inside the container; the TNT melted and mixed with the ZnS. As the heating continued, the TNT near the edge of the metal container began to boil and decompose. This decomposition leads to complete deflagration of the TNT that was distributed around the ZnS phosphor transferring heat to the ZnS phosphor. This was essentially a fast heat treatment process, without an explosion. If the proper conditions are selected, the ZnS phosphor mixture is heated above the transition of cubic to hexagonal structure at 1019°C and allows for thermally activated diffusion of the activators in the phosphor mixture. The containment of the product gases is necessary to attain good combustion of the TNT without losing the TNT vapor to boiling or loss of heat by the exhaust of hot product gases. As the

chamber holds the hot gases the ZnS phosphor reaches a higher temperature more homogeneously. The heat is then quickly lost to the colder container allowing the temperature to drop below 800°C, an important temperature that will prevent thermal activated processes such as transformation of hexagonal phase back to the cubic phase, and grain growth.

Explosive generated shockwaves can also be used for processing luminescent material. Double cylinder implosion experiments were performed on the same phosphor mixture at room temperature and elevated temperature to investigate the change in material properties. Zinc sulfide and a mixture of other powders were placed in a container and impacted by an explosively driven flyer pipe. In some cases the powders were heated. After heating, the central powder container was lowered into the explosive container. The flyer pipe was accelerated across a gap, by an explosive, toward the central axis causing a radial focusing of the pressure and high pressure compaction of the starting powders. The high pressure and high temperature of the compaction caused changes in the luminescent response of the powders.

Results of photoluminescent measurements, x-ray diffraction and SEM observation will be presented along with a discussion of these results in performance of the two methods.