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Synthesis of submicron-sized spherical green phosphors by reverse emulsion method and their application to phosphor inks for ink-jet process in PDP

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Abstract

Sphere-shaped green phosphor, Zn_2SiO_4:Mn, with 100–500 nm of average diameter was successfully prepared by the reverse emulsion method to formulate the phosphor ink for ink-jet processing. It was found that the aqueous phosphor ink exhibited excellent dispersion stability by introducing organic low molecular weight additives such as nonionic type of fatty acid containing ethylene oxide (BYK 192®), 3-(2-aminoethyl)aminopropyl trimethoxy silane (SA0700®) and acetic acid, due to the combination of the steric hindrance originated from BYK 192® and charge repulsion from SA0700® and acetic acid. The patterned phosphor layers with thickness uniformity (±0.008 μm to ± 0.055 μm depending on the formulation of phosphor inks) and precisely controlled thickness (in the range of 5–50 μm) in between barrier ribs could be obtained by using ink-jet printing with optimized process parameters such as nozzle diameter, dispensing pressure and nozzle moving speed. Optical properties of the resulting phosphor layers fired at different temperatures were compared in terms of PL emission intensity and color coordinate.

Keywords: Spherical phosphor; Ink-jet processing; Reverse emulsion; Phosphor ink; PDP

1. Introduction

The phosphor pattern on the rear plate of plasma display panel (PDP) can be fabricated by several methods including screen printing, electro-deposition, photolithographic processing and ink-jet processing technology [1–3]. Of these methods, screen printing and photolithographic processing have been widely used for patterning of phosphor layer in PDP industry, but they are disadvantageous in terms of their intricate processes and excessive loss of expensive phosphor material. To solve these problems such as high cost and low productivity, ink-jet processing has been recently investigated in PDP industry. Hereafter, ink-jet processing technology with the precision nozzle is considered to be the adequate method for phosphor patterning in manufacturing of high resolution PDP [4–7].

Conventional phosphors such as red [$(Y,Gd)BO_3:Eu^{+3}$], green [$Zn_2SiO_4:Mn^{+2}$], and blue [$BaMgAl_{10}O_{17}$] phosphor used widely in PDP industry so far have the following characteristics [8]; average diameter of phosphors is in the range of 1–3 μm, and their shape is irregular, for example, spherical, dumbbell and plate form. Therefore, conventional green and blue phosphors which have micron-sized aspherical shape are not appropriate to the ink-jet processing. The spherical and smaller (under several hundreds of nanometer or submicron-sized) phosphors are required to get uniform jetting property and to prevent clogging of fine nozzle

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