Moisture-induced thermal degradation of red-emitting CaAlSiN₃:Eu

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In recent years, CaAlSiN₃ has drawn much attention for its application in warm white or high color rendition LEDs because it is a highly efficient orange or red phosphor with high quenching temperature. Various researches have been devoted to the synthesis, structure, luminescence, and applications of CaAlSiN₃. On the other hand, besides the parameters of luminescence spectra, quantum efficiency and thermal quenching, luminescence degradation is a big challenge, preventing phosphors from commercialization. Degradation as an irreversible transformation is different from luminescence quenching, so that only thermal quenching is not sufficient for evaluating a phosphor, and thermal- or moisture-induced degradation should also be investigated.

In this study, the moisture-induced degradation of SCASN was comprehensively investigated by treating it under a severe condition of high-pressure water steam. The degradation initiated at 150°C, and the luminescence of SCASN was seen to be quenched quickly (see Fig.1), with the powder sample being bleached after the treatment. Both of the microstructure and phase changed obviously with the oxidation, and the host turned finally into NH₃, (Sr,Ca)Al₂Si₂O₈ and Ca(OH)₂. By using a variety of spectroscopic, surface and microstructure analytic techniques, the degradation mechanism was clarified and proposed to occur via the oxidant-gas penetration mechanism through the moisture-enhanced oxidation of both the SCASN host and divalent europium.

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