Scintillation Properties of Nd^{3+}-Doped Lu_2O_3 Ceramics in the Visible and Near InfraRed Regions

Introductory. Nd:Lu_2O_3 ceramics were deeply studied for laser application and prepared in 2014 by the nonconventional spark plasma sintering (SPS) method. Radio-luminescence of the same ceramics was also observed, and several scintillation emission peaks were reported at 300–1200 nm under X-ray excitation. The near infrared emission within 900-1100 nm of the $^4F_{3/2} \rightarrow {}^4I_i$ (i = 11/2, 9/2) transitions of Nd^{3+} ions corresponding to the "human window" was successfully detected. Thus, Nd:Lu_2O_3 ceramics can be proposed as a candidate in medical applications including the dosimetry for radiation therapy. We propose to extend the topics in 2015 on rare earth-free scintillators as well as powder phosphors.

Nd^{3+}-doped Lu_2O_3 (Nd:Lu_2O_3) is a candidate for an infrared scintillator because (i) Lu_2O_3 has a high density of 9.5 g/cm^3 and a high atomic number of 67 and (ii) Nd^{3+}-doped materials emit in the infrared range and the emission lines from Nd^{3+} can be used in medical applications since human body has a transparency window between 600 and 1,100 nm. However, it is extremely difficult to fabricate Lu_2O_3 single crystals using conventional crystal growth methods because of the high melting point (2,510 °C). Using solid-state reactions, it is much easier to fabricate Lu_2O_3 into a ceramic structure. Therefore, Nd:Lu_2O_3 transparent ceramics were fabricated using a novel spark plasma sintering (SPS) method as can be seen in Fig. 1, [1]. This technique is comparatively simple and consumes less time than other methods such as vacuum hot pressing.

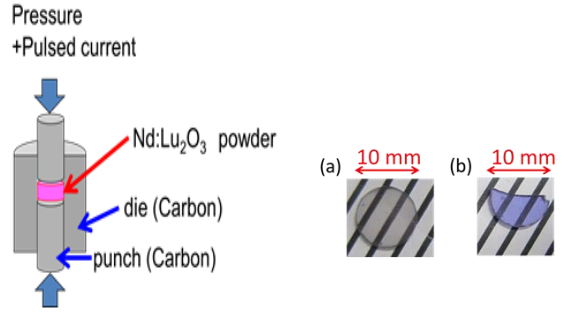

Fig. 1 Schematic view of SPS technique to fabricate Lu2O3 ceramics doped with 0.1 mol% (a) and 5.0 mol% (b) of Nd (after polishing).

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The scintillation properties and transmittance spectra of the as-produced ceramics were studied in both the visible and the near infrared regions. Fig. 2 shows the radio-luminescence spectra measured in the range 800–1200 nm. Nd^{3+} emission lines were observed in the transparency window of human body. Thus, these ceramic materials could be a candidate for medical imaging applications [2].
The next analysis will be to develop a generic study on RE-free scintillators as well as powder phosphors and to develop new material conceptions in this field which have potential to provide commercially successful materials for several applications.

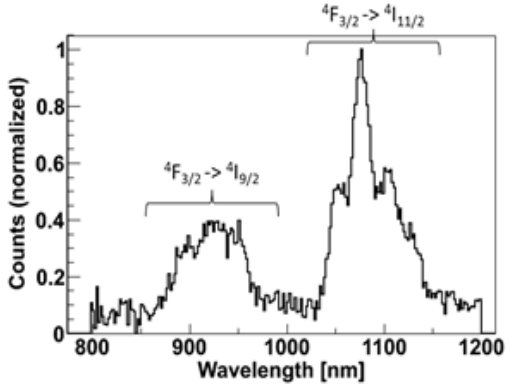

Fig. 2 X-ray-excited radio-luminescence of 0.5 mol% Nd:Lu_2O_3 in the near infrared region corresponding to the human window.

References

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