Electronic Supplementary Information

Samarium and manganese incorporation to improve color rendering of LuAG:Ce\textsuperscript{3+} phosphor ceramic for laser-driven lighting: Color-tunable and energy transfer study

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Supplementary Information

The in-line transmission spectra and appearances of polished LuAG:0.04Sm\textsuperscript{3+} and LuAG:0.02Ce\textsuperscript{3+},0.04Sm\textsuperscript{3+} ceramics (1.0 mm thick) were shown in Fig. S3. These samples presented a transparent appearance, and the words behind them could be recognized by naked eyes under daylight. The in-line transmittance of LuAG:0.02Ce\textsuperscript{3+},0.04Sm\textsuperscript{3+} ceramic reached 83.3\% at 800 nm, which was higher than that of LuAG:0.04Sm\textsuperscript{3+} ceramic (73.8\% at 800 nm). This result implies appropriate rare earth or transition ions doping is in favor of promoting densification process in sintering stage, thus improving optical quality of LuAG:0.02Ce\textsuperscript{3+},0.04Sm\textsuperscript{3+} ceramic. Similar phenomenon has been reported in other literatures.\textsuperscript{1,2} In addition, two broad absorption band located at 340 and 445 nm were originated from 4f-5d\textsuperscript{1} and 4f-5d\textsuperscript{2} transition of Ce\textsuperscript{3+} in LuAG:0.02Ce\textsuperscript{3+},0.04Sm\textsuperscript{3+} ceramic, respectively. Although most of the intrinsic absorption bands of Sm\textsuperscript{3+} were covered by those of Ce\textsuperscript{3+}, while an absorption centered at 377 nm could also be observed in Ce\textsuperscript{3+}, Sm\textsuperscript{3+} co-doped samples, corresponding to the \textsuperscript{6}H\textsubscript{5/2}→\textsuperscript{6}P\textsubscript{7/2} transition of Sm\textsuperscript{3+} ion.
Supplementary Figures

Single structured phosphor ceramic

Fig. S1 The CRI value of single-structured phosphor ceramics based on different design strategies

Fig. S2 Evolution of lattice volume depending on the Sm concentration
Fig. S3 In-line transmittance of as-prepared LuAG:0.04Sm$^{3+}$ and LuAG:0.02Ce$^{3+}$,0.04Sm$^{3+}$ ceramics

Fig. S4 Excitation-wavelength-dependent emission mappings for representative LuAG:0.02Ce$^{3+}$,0.04Sm$^{3+}$ ceramics.
Fig. S5 Excitation-wavelength-dependent emission mappings for representative LuAG:0.02Ce$^{3+}$,0.04Sm$^{3+}$ ceramics.

Fig. S6 (A) Temperature-dependent PL spectrum of YAG:0.02Ce$^{3+}$,0.04Sm$^{3+}$ ceramics. Trend of the integral intensity of (B) the whole spectra with the same temperature range.
Fig. S7 In-line transmittance and appearance of as-prepared LuAG:0.02Ce$^{3+}$,0.04Sm$^{4+}$,0.04Mn$^{2+}$ ceramic

Fig. S8 PLE spectrum (curve a, $\lambda_{em}=618$ nm) of LuAG:0.04Sm$^{3+}$ ceramics and PL spectrum of LuAG:0.02Ce$^{3+}$ (curve b, $\lambda_{ex}=450$ nm) and LuAG:0.04Mn$^{2+}$ (curve c, $\lambda_{ex}=450$ nm) ceramics.

Supplementary References