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Sr^{2+} substitution for Ca^{2+} and Eu^{2+},Dy^{3+} Co-doping enhance mechanoluminescence of $CaAl_2Si_2O_8$ Phosphors

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Abstract: A series of phosphors $(Ca_{1-x}Sr_x)Al_2Si_2O_8:Eu^{2+},Dy^{3+}$ (x = 0.1, 0.2, 0.3, 0.4, 0.5, 0.8) and $Ca_{0.6}Sr_{0.4}Al_2Si_2O_8:yEu^{2+},2yDy^{3+}$ (y = 0.005, 0.01, 0.015, 0.02) were prepared. It was found $Ca_{0.6}Sr_{0.4}Al_2Si_2O_8:Eu^{2+},Dy^{3+}$ achieved the highest mechanoluminescence intensity, and the optimal Eu^{2+} and Dy^{3+} co-doping contents were 1% and 2%, respectively. The emission peak of $Ca_{0.6}Sr_{0.4}Al_2Si_2O_8:0.01Eu^{2+},0.02Dy^{3+}$ was located at 413 nm on ML spectrum, which was similar to the photoluminescence, indicating both mechanoluminescence and photoluminescence were attributed to the $4f^65d^1 \rightarrow 4f^7$ transition of Eu^{2+}. Also $Ca_{0.6}Sr_{0.4}Al_2Si_2O_8:0.01Eu^{2+},0.02Dy^{3+}$ exhibited an excellent threshold force (130 N) in the extremely broad tested force range (130 - 3,000 N) and kept a nearly perfect linear response, which made it a potential candidate for application of pressure sensors. The introduction of Sr^{2+}, Eu^{2+} and Dy^{3+} caused lattice distortion, formation of more defects, and thus generation of more suitable traps to capture the electronic carriers under ultraviolet excitation. Increasing the number of traps and tuning of the trap depth were found to increase the mechanoluminescence response.

Keywords: phosphors; mechanoluminescence; lattice distortion; traps.