Properties of ultrasound induced luminescence of $LiTaO_3$:Pr at kHz and MHz frequency ranges

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Light emission from LiTaO3:Pr during exposure of low (20 kHz) and high (3.3 MHz) frequency ultrasonic waves are presented. After being charged at ~270 nm, the phosphor emits light with three prominent peak bands at 511 nm, 618 nm, and 892 nm, as observed in both photoluminescence and mechanoluminescence spectra. The unlike acoustic phenomena at low (acoustic cavity) and high (acoustic streaming) frequency pointed at a distinct mechanism for the light emission: i) ML-driven and ii) TL-driven for low and high frequency, respectively. Moreover, the activation energy of the traps (i.e. the trap depth) are modulated by tuning the praseodymium concentration (1% (sample S1), 3% (S2) and 3% (S4)). We used this to demonstrate diverse behavior of ultrasound induced light emission at various thermal conditions. Aimed at application purpose, S1 is advantageous for high-intensity emission and long distance detection, S2 is suitable for scenarios demanding good reproducibility, and S3 proves to be valuable for fast response to ultrasound. Additionally, the presented study offers a comprehensive roadmap for understanding of the correlation between ultrasound induced luminescence and the energy distribution of trap depths.

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