Wide-range correlated color temperature white light generation from in $\text{Er}^{3+}/\text{Yb}^{3+}$ codoped $\text{B}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-KF-LiO}$ (BAKL) nano glass ceramic

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To achieve efficient white light upconversion emission in rare earth doped materials is a major challenge to the researchers [1]. There are many such reports where white light upconversion emission is achieved using suitable combination of rare earth ions e.g. $\text{Er}^{3+}/\text{Tm}^{3+}/\text{Yb}^{3+}$ system. The Er^{3+} is suitable for this purpose since it gives efficient sharp upconversion emission bands around 550 and 650 nm wavelengths. However, the colour purity obtained thus is far from the standard (NTSC) value. In our study we showed that color tuning in $\text{Er}^{3+}/\text{Yb}^{3+}$ co-doped $\text{B}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-KF-LiO}$ (BAKL) glass ceramics can be made by varying the excitation power density. Also the color correlated temperature of the sample varies from 4662k to 6869k with different pump power excitation. A broad emission band extending from 525 nm to 565 nm is observed in this host. Here in the host material B_2O_3 is added to give maximum strength to the material, KF is added to give low phonon environment to the material also Al_2O_3 work as novel glass modifier [2].

Novel transparent oxyfluoride glass-ceramic $\text{B}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-KF-LiO}$ (BAKL) with $\text{Er}^{3+}/\text{Yb}^{3+}$ doped was successfully prepared by melt-quenching technique with further thermal treatment to convert glass phase into glass-ceramic. Their structural and luminescent properties were investigated systemically by XRD, FESEM, UV-Vis absorption study, upconversion spectra and CIE diagram & color purity calculator.

The global emission associated with the Er^{3+} transitions observed upon 980 nm excitation was characterized by its CIE 1931 chromaticity coordinates. The CIE (International Commission on Illumination) chromaticity diagram of BAKL: $\text{Er}^{3+}/\text{Yb}^{3+}$ glass-ceramics for different pump power with same concentrations is observed (figure 1). CIE parameters such as colour coordinates (x, y) and CCT were calculated to characterize the colour emission. The colour coordinates were determined using the Colour calculator software. Such coordinates (0.32, 0.39) resulted to be in the white light region. The quality of this white light was inspected with the correlated color temperature (CCT). The CCT is given by the McCamy empirical formula

$$\text{CCT} = -449n^3 + 3525n^2 + 6823n + 5520.33$$

Where $n = (x-x_e)/(y-y_e)$ is the reciprocal slope and ($x_e=0.332$, $y_e=0.186$) the epicenter of the isothermperature lines. The CCT value calculated for the BAKL glass ceramics excited at 980 nm resulted to be 5929.55K, which corresponds to warm color temperature. Therefore, the BAKL glass ceramics can generate warm white yellow light emission, so that it could be suitable for solid state lighting technology as a warm white light source

In summary Under power tunable 980 nm laser excitation, the samples exhibited characteristic emissions of Er^{3+} . Attractively, the upconversion emissions of Er^{3+} , especially green and near-infrared emissions, were greatly enhanced (by 10 times) after crystallization. The incorporation of Er^{3+} into BAKL nano-crystals with lower phonon environment was responsible for the phenomenon. Our research may enrich the understanding of white light generation from fluoride nano crystal based transparent oxyfluoride glass ceramics

Figure 1: Upconversion spectra of GC (lexcitation=980nm), Upconversion Emission Intensity on different pump power for in $\text{Er}^{3+}/\text{Yb}^{3+}$ co-doped $\text{B}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-KF-LiO}$ (BAKL) Glass Ceramics

References

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