Light emitting diodes (LEDs) widely replaced conventional light sources like incandescent and fluorescent lamps. This is due to their longer lifetime, higher wall plug efficiency, and high colour rendering index (CRI). Commercially available LEDs comprising a blue emitting LED chip coated with a yellow emitting phosphor such as YAG:Ce exhibit high luminous efficacies. However, due to the weak intensity of red emission, the overall spectrum results in a high correlated colour temperature (CCT) and low CRI. Therefore, introducing a red emitting phosphor is inevitable to achieve lower CCTs and higher CRIs. Eu\(^{3+}\)-activated phosphors show great potential use in LEDs, but suffer from low absorption in the blue spectral range. Hence, a sensitizer such as Tb\(^{3+}\) has to be used.

### Background

Preparation via solid state method

Li\(_2\)CO\(_3\), BaCO\(_3\), Tb\(_2\)O\(_3\), MoO\(_3\) and Eu\(_2\)O\(_3\) were ground with acetone in an agate mortar

Dried mixtures were placed in a ceramic crucible and were fired at 800 °C for 10 h in air

Tb\(^{3+}\) in Tb\(_2\)O\(_3\) is reduced to Tb\(^{4+}\) during sintering

### Experimental Section

- Efficient energy transfer from Tb\(^{3+}\) to Eu\(^{3+}\) upon excitation at 487 nm, which results in an emission at 615 nm
- Already at 10% Eu\(^{3+}\) concentration an energy transfer efficiency of 100% can be achieved
- Observed rise time decreases with increasing Eu\(^{3+}\) concentration which also leads to a higher energy transfer rate
- Diffuse reflectance spectrum reveals a white body colour
- \(T_{1/2}\) of co-doped sample was found to be 457 K
- No shift of colour point is observed with increasing temperature
- Phosphor is excitable with a 465 nm LED and leads to efficient red and blue emission

### Results and Discussion

![Table 1: Tb\(^{3+}\) (Excitation: 465 nm) and Eu\(^{3+}\) (Excitation: 1128 nm) intraconfigurational transitions with their respective peak wavelengths and overlap integrals](image)

![Fig. 2 Schematic drawing of the proposed Tb\(^{3+}\) to Eu\(^{3+}\) energy transfer mechanism](image)

![Fig. 3 Energy transfer efficiency and energy transfer rate as function of Eu\(^{3+}\) concentration](image)

![Fig. 4 Decay curves of Li\(_2\)Ba\(_2\)Tb\(_3\)(MoO\(_4\))\(_8\) with \(x = 0.0\) to \(0.8\)](image)

![Fig. 6 Emission spectrum of a 465 nm LED behind a Li\(_2\)Ba\(_2\)Tb\(_3\)(MoO\(_4\))\(_8\) ceramic disc.](image)

![Fig. 7 Emission spectrum of a 465 nm LED behind a Li\(_2\)Ba\(_2\)Tb\(_3\)(MoO\(_4\))\(_8\) ceramic disc.](image)

![Fig. 8 Emission spectrum of a 465 nm LED behind a Li\(_2\)Ba\(_2\)Tb\(_3\)(MoO\(_4\))\(_8\) ceramic disc.](image)

![Fig. 9 Emission integrals as a function of temperature](image)