In recent years, rare earth ions have played a prominent role in the development of new phosphor materials for both displays and lighting. Notably, the Ce$^{3+}$ and Eu$^{2+}$ ions have almost monopolized the field. They show, in contrast to other rare earth ions, broad excitation bands with high absorption strength and broad emission bands. In phosphor converted LEDs, YAG:Ce, LuAG:Ce and Eu-doped nitrides provide yellow, green and red emission with high quantum efficiency. This has led to record efficiencies for white LEDs over 300 lm/W [1] on a lab scale (close to the theoretical maximum) and device efficiencies of over 150 lm/W currently on the market [2].

Based on these developments, one would be tempted to conclude that further research on phosphors for visible emission is superfluous. However, even the ubiquitous Ce$^{3+}$ and Eu$^{2+}$ ions have their limitations. In lighting, only a limited number of hosts for Eu$^{2+}$ allow to achieve sufficiently long emission wavelengths for saturated red emission, and their spectrum is so broad that it is partly situated in a wavelength range where the human eye sensitivity is very low. Also for displays, the broad emission spectra constitute a drawback, since they need heavy filtering to obtain the saturated colors necessary to yield displays with a wide color gamut.

In this presentation, we will focus on the areas where there is still room for improvement in performance of rare earth based phosphors. Next, we will also highlight the new Mn$^{4+}$ and Cr$^{3+}$ transition metal based phosphors which have complementary properties and allow to expand the application area of phosphors with both high quantum efficiency narrowband emission and longer emission wavelengths.