Efficient solid-state lighting (SSL) devices are typically composed of a blue LED chip and a yellow phosphor. I investigate the structure—property—composition relationships of these inorganic phosphors, which are used in SSL to down-convert blue light to yellow-orange light. The optical properties of phosphors are critically dependent on the activator ion (Ce$^{3+}$, Eu$^{2+}$, etc.) which is substituted at around 1 mole percent into a crystalline lattice (e.g. Y$_3$Al$_5$O$_{12}$, YAG).

I use state-of-the-art experimental methods (solid-state NMR, XANES/EXAFS, synchrotron X-ray and neutron scattering) and computational methods such as Reverse Monte Carlo (RMC) simulations of total neutron scattering) to elucidate the local structure and long-range order of phosphor materials. The structure and composition are then related to optical properties such as time- and temperature-dependent photoluminescence (PL) spectra as well as the quantum efficiency. The eventual goal is to design a cost-competitive solid-state white lighting device that is much more efficient than current lighting sources.