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# Rare-Earth Doped Materials

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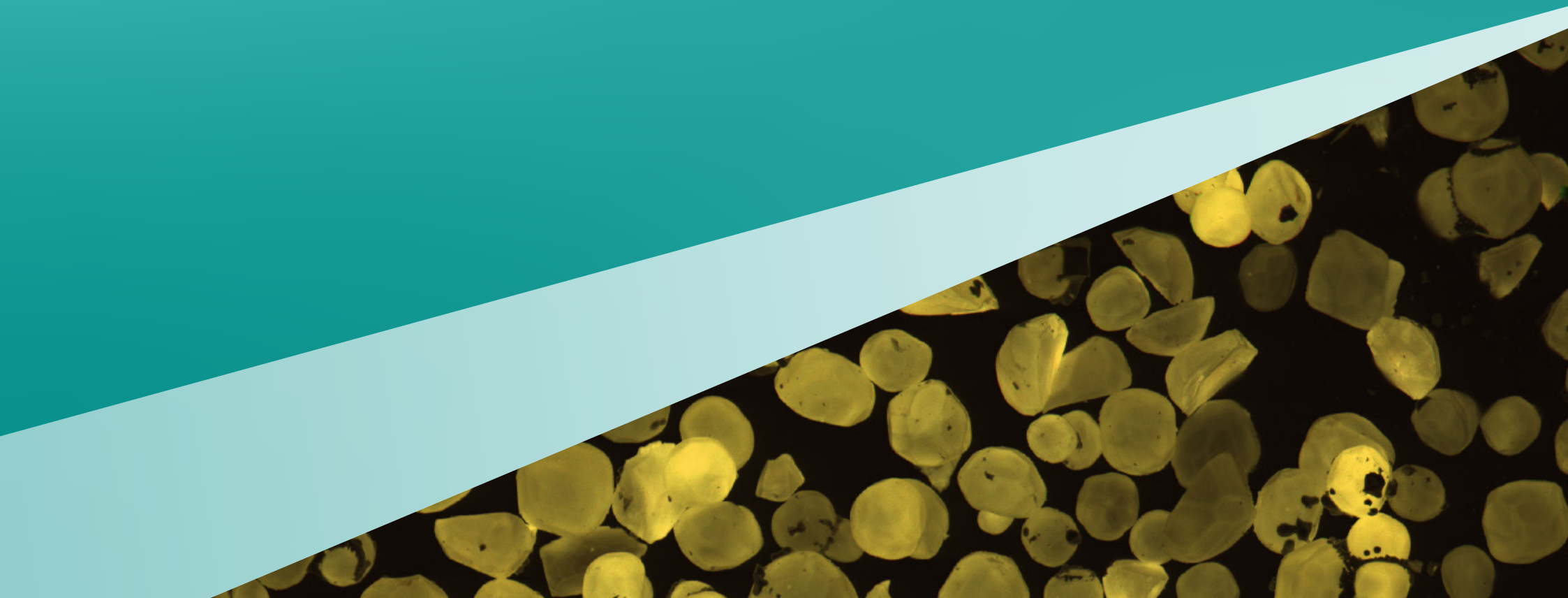

# Rare-Earth Doped Materials

Rare earth metals represent a particular class of elements in the periodic table, consisting of the lanthanide metal series combined with yttrium and scandium (**see Figure 1)**. Incidentally, it has been discovered that these elements are not as rare as previously thought. However, they are still referred to as such. Cathodoluminescence is a useful technique for observing such materials.

**Rare-earth materials**

Crystalline host materials such as silica ($SiO_2$), sapphire ($Al_2O_3$), yttrium aluminium garnet (YAG), yttrium oxide ($Y_2O_3$), gadolinium oxide ($Gd_2O_3$), or yttrium vanadate (YVO). They can be doped with rare-earth metal ions which gives them unique optical properties.

Many of the optical transitions in lanthanide doped materials are intra-4f transitions. The 4f electron shell is shielded from the environment, e.g. crystal field effects and phonon coupling, by the filled 5s and 5p shells. As a result, these transitions are rather insensitive to the host and somewhat similar to free ion emission. Furthermore, they often have small linewidths and correspondingly long lifetimes up to the ms range.

By using different lanthanide ions (mostly trivalent ions) a wide range of such intense transitions can be engineered all throughout the visible and infrared spectral region [1]. As such, these materials are employed for a large variety of applications. In particular, they can be used to make efficient visible and IR (fiber) lasers.

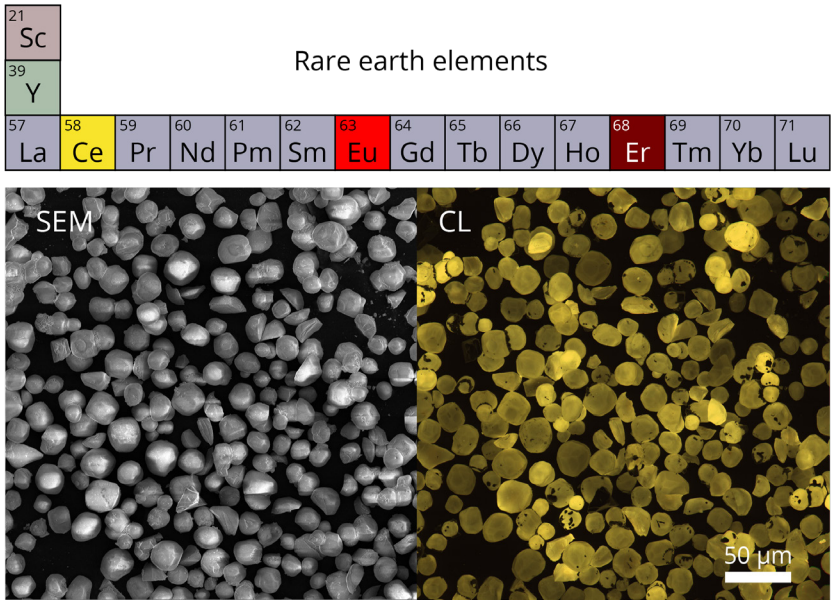


*Figure 1: Part of the periodic table corresponding to the rare-earth metals. Below a SEM image of YAG:$Ce^{3+}$ particles is shown together with an RGB CL image which was constructed from three RGB color-filtered CL intensity maps as measured with a PMT (t = 10 µs, HV = 10 kV, I = 35 pA). Sample courtesy of Professor Xia.*