Exercises Luminescence Mechanisms

1. Please explain the position of the energy level of an activator, a sensitizer, an ionization level and the donor and acceptor position for a host material with the band gap E_G by the help of an energy schema in the location domain!

2. Please sketch the dependence of the quantum yield (QY) of a luminescent material as a function of concentration of the activator ion! Explain the phenomenon of concentration quenching by the help of a graph! What is meant by internal and external QY?

3. Please explain the term sensitisation with a self-imposed example!

4. Please name three options for sensitisation of a trivalent activator taken from the lanthanide series!

5. Please explain the importance of lanthanide ions as activators in many phosphors.

6. Please differentiate the terms energy transfer and charge transfer.

7. Please name the dominant luminescence mechanism causing the photoluminescence of the following activators moieties:

    a. Cr^{3+}

    b. Sn^{2+}

    c. Ce^{3+}

    d. Sm^{3+}

    e. Eu^{3+}

    f. Eu^{2+}

    g. Gd^{3+}

    h. Yb^{3+}

    i. WO_4^{2-}

    j. Mn^{4+}

8. Please explain the relative position of CT-level and the lowest crystal field component of the $[Xe]4f^{n-1}5d^1$ configuration for the lanthanide ions Eu^{2+} and Eu^{3+} as a function of the chemical environment!

9. The afterglow pigment $Sr_4Al_{14}O_{25}$:Eu,Dy should be modified so that the afterglow occur only at a temperature which is significantly above room temperature. Propose a suitable co-dopant and explain your proposal by the aid of an energy level diagram!

10. You should develop a green emitting luminescent material for the use as a converter in blue emitting LEDs (440-480 nm). Which activator and host lattice could be used? Which physical methods do you use to characterise the newly developed luminescent material with the aim of improving the quality?

11. You have the red emitting luminescent materials (Y,Gd)BO_3:Eu, Y_2O_3:Eu, Y_2O_2S:Eu, YVO_4:Eu, $Sr_2Si_5N_8$:Eu, $CaAlSiN_3$:Eu and CaS:Eu at hand. Which of these materials is suitable for the use in fluorescent lamps, plasma TV, or inorganic LEDs?

12. Please explain the term afterglow pigment! Why Eu^{2+} phosphors exhibit particularly common afterglow? Please explain this by the help of an energy level scheme!

13. What is meant by the term “storage phosphors”? Name an example!

14. Which activator ion would you choose to dope a YAG crystal to obtain a material with emission in UV-B, in UV-A, in the blue, in the green, in the red or in the near or the mid infrared spectral range?

15. Please explain the term down-conversion and propose a well justified activator for such a process.

16. Up-conversion is the emission of a higher energetic photon after the absorption of a lower energetic photon. Please explain this process by the aid of the following physical phenomena:

    a. Anti-Stokes-Raman

    b. Excited State Absorption

    c. Energy transfer up-conversion

    d. Sensitized energy transfer up-conversion