Examination

“Material Characterisation – Optical Spectroscopy (Prof. Dr. Jüstel)”

Date: March 16th, 2017 **Max. 25 Points**

Name, Given name: **Enrolment number:**

Please only use these sheets (you might also use the reverse)!

Task 1) (5 Points)

Fundamentals of Spectroscopy

a) Define the term quantum yield! (1 Point)

b) Please differentiate the terms “radiometric quantities” and “photometric quantities”! (2 Points)

c) What is meant by the term actinometry? Please also name a photochemical reaction that is used for actinometry! (2 Points)

Task 2) **(5 Points)**

Luminescence spectroscopy

a) Sketch the build-up of a typical fluorescence spectrometer and give examples of all required optical components! (3 Points)

b) Describe the way to record an emission spectrum of a luminescent material, e.g. of $LaPO_4:Ce^{3+}$ powder that shows the lowest 4f5d excitation band at 270 nm! (1 Point)

c) Describe the way to record an excitation spectrum of a luminescent material, e.g. of $LaPO_4:Ce^{3+}$ powder that shows a broad emission band at 320 nm! (1 Point)

Task 3) **(5 Points)**

Radiation Sources for Optical Spectroscopy

What kind of radiation sources can be used for the following measurement purposes? Explain your choice! (1 Point each)

a) Absorption spectrum between 300 and 1000 nm

b) Emission spectrum between 500 and 800 nm under 450 nm excitation

c) Excitation spectrum between 250 and 500 nm

d) Excitation spectrum between 100 and 300 nm

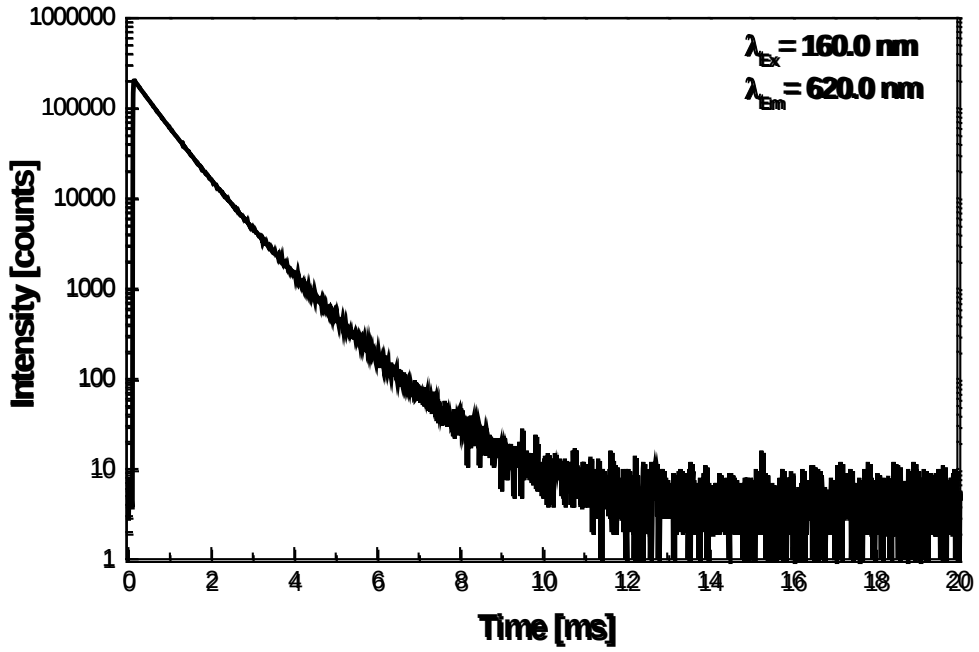
e) Decay curve under 395 nm excitation

Task 4) **(5 Points)**

Time resolved spectroscopy

a) Describe the procedure to record a decay curve of an arbitrary luminescent material! (2 Points)

b) The figure below displays the decay curve of $YVO_4:Eu^{3+}$, which is applied in high-pressure Hg discharge lamps and plasma displays. Please determine the decay constants $\tau_{1/e}$ and $\tau_{1/10}$ from the following graph! (1 Point)



c) Please name a potential cause for the deviation of the curve from linearity for the above given log(Intensity) over time t plot! (1 Point)

d) Select a function for the fitting of the decay curve shown above and explain your choice! (1 Point)

$I(t) = A_0 - B_1 * t/\tau_1$

$I(t) = A_0 + B_1 * \exp(-t/\tau_1)$

$I(t) = A_0 + B_1 * \exp(-t/\tau_1) + B_2 * \exp(-t/\tau_2)$

Task 5) **(5 Points)**

Temperature resolved spectroscopy

a) Describe the way to record a thermal quenching curve and to fit the experimental data by the so-called Struck-Fonger equation! (3 Points)

$I(T) = A_0 + I_0/(1 + B\exp(-\Delta E/kT))$ „Struck-Fonger-Equation“

b) Draw the shape of a typical thermal quenching curve in a respective intensity-temperature diagram and assign the $T_{1/2}$ value! (2 Points)