Examination

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

Date: February 02nd, 2012 **Max. 25 Points**

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

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

Task 1) (5 Points)

Quantities and Terms

Please explain the following expressions!

a) Radiometric quantities

b) Photometric quantities

c) Specular reflection

d) Diffuse reflection

e) Actinometry

Task 2) **(6 Points)**

Luminescence spectroscopy

a) Sketch the build-up of a typical fluorescence spectrometer and assign all required optical components!

b) Describe the way to record an emission spectrum of a luminescent material, e.g. of Y_2O_3:Eu^{3+} powder, that shows a charge-transfer transition at 230 nm!

c) Describe the way to record an excitation spectrum of a luminescent material, e.g. of Y_2O_3:Eu^{3+} powder, that shows an emission line at 611 nm!

d) Why is it commonly necessary to correct excitation spectra? Please also describe the process of the correction!

Task 3) **(6 Points)**

Reflection spectroscopy

a) Sketch the build-up of a typical reflection spectrometer and assign all required optical components!

b) What is the function of the Ulbricht sphere?

c) Please explain by taking the Kubelka-Munk-Function ($R\infty$ = reflectance, A = absorption coefficient und S = scattering coefficient) into account, why completely black substances do not exist!

Kubelka-Munk-Function: $$F(R_\infty) = \frac{A}{S} = \frac{(1-R_\infty)^2}{2 \cdot R_\infty}$$

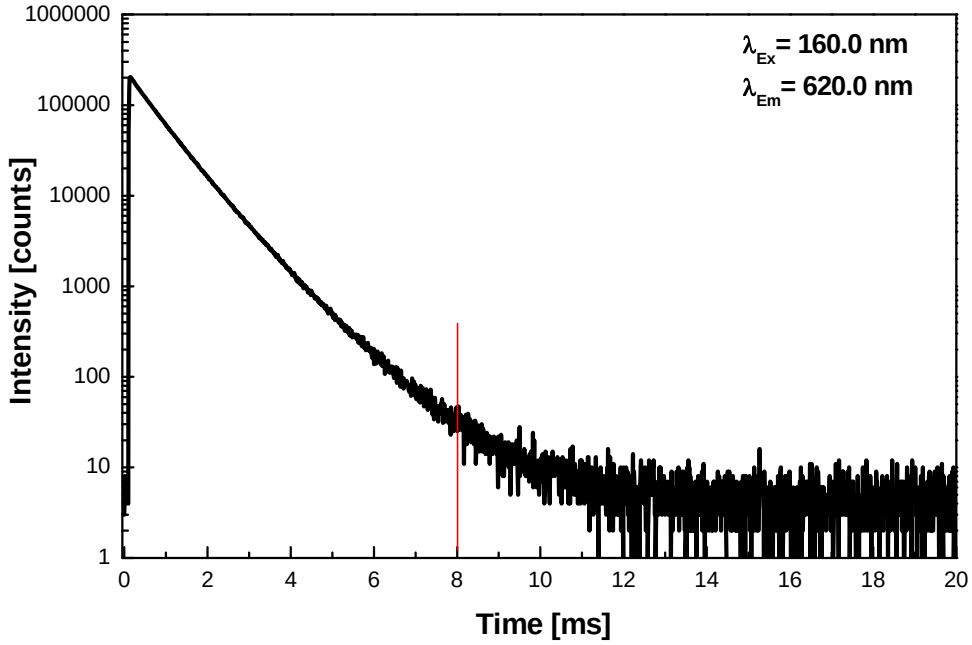
d) Do completely white substances exist in accordance to this function? Please explain!

Task 4) **(4 Points)**

Time resolved spectroscopy

a) Describe the way to record a decay curve of a luminescent material,

b) The figure below displays the decay curve of the high-pressure discharge lamp phosphor $YVO_4:Eu^{3+}$. Please determine the decay constants $\tau_{1/e}$ and $\tau_{1/10}$!



c) Please name a potential cause for the deviation of the curve from linearity for the above given log(Intensity) over time t plot about 5 ms after the excitation source has been switched off!

Task 5) (4 Points)

Temperature resolved spectroscopy

a) Describe the way to record a thermal quenching curve and to determine the temperature $T_{1/2}$, i.e. the temperature, at which the luminescence intensity drops down to 50% relative to the low temperature luminescence intensity!

b) Draw the shape of a typical thermal quenching curve in a respective diagram!