Examination

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

Date: March 10th, 2016 **Max. 25 Points**

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

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

Task 1) (4 Points)

Basics of Optical Spectroscopy

Sketch the arrangement of the basic components of a spectrometer set-up for the following purposes! Give also for each component an example for a widely applied device! (Each 2 Points)

a) Emission and Excitation Spectroscopy

b) Reflection Spectroscopy

Task 2) (6 Points)

Absorption and Reflection Spectroscopy

$Y_3Al_5O_{12}$ is a widely applied host for luminescent and laser materials, whereby the optical band gap is about 7.0 eV (56500 cm^{-1}).

a) Describe the way to determine the absorption spectrum of a YAG single crystal (2 Points)

b) Describe the way to determine the absorption spectrum of a YAG microscale powder (2 Points)

c) Clarify by means of the Kubelka-Munk function, whether completely white or black substances may exist! (2 Points)

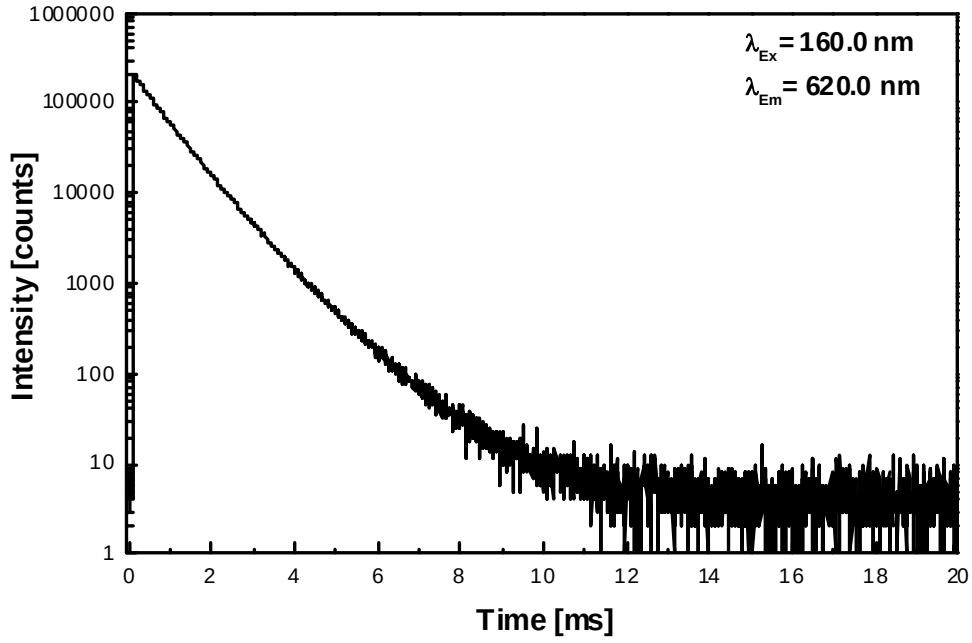
Kubelka-Munk-Function: $$F(R_\infty) = \frac{A}{S} = \frac{(1-R_\infty)^2}{2 \cdot R_\infty}$$

Task 3) **(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 4) (5 Points)

Temperature resolved spectroscopy - Thermoluminescence

a) Describe the procedure to record a glow curve of an arbitrary luminescent material! (3 Points)

b) Which information can be derived from a glow curve? (2 Points)

Task 5) **(5 Points)**

Temperature resolved spectroscopy - Thermal quenching

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)

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

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