Examination

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

Date: March 14th, 2013 **Max. 25 Points**

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

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

Task 1) (6 Points)

Radiation Sources for Optical Spectroscopy

What kind of radiation sources can be used for the following measurement purposes? Explain your choice!

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 450 nm excitation

f) Decay curve under 254 nm excitation

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 YAG:Ce^{3+} powder, that shows an intense 4f5d transition at 460 nm!

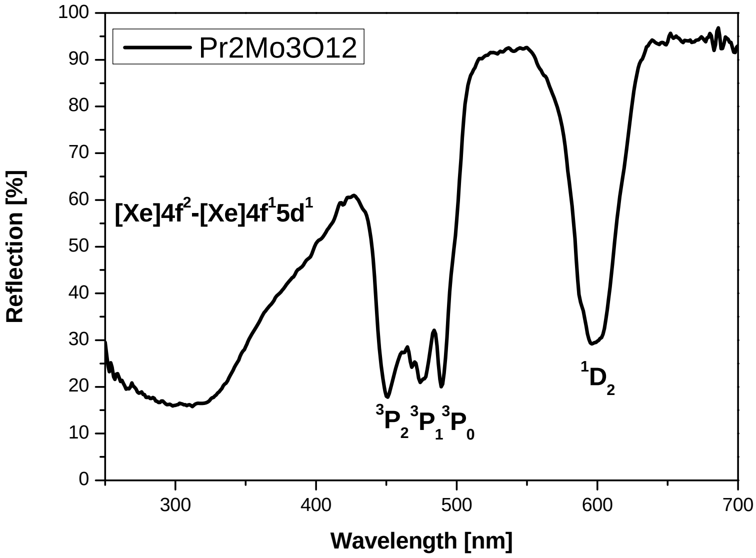
c) Describe the way to record an excitation spectrum of a luminescent material, e.g. of YAG:Ce^{3+} powder, that shows an emission band at 545 nm!

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

Task 3) **(5 Points)**

Reflection Spectroscopy

A $Pr_2Mo_3O_{12}$ sample with an average particle size of d_{50} = 10 µm exhibits the following reflection spectrum:



$$F(R_\infty) = \frac{A}{S} = \frac{(1-R_\infty)^2}{2\cdot R_\infty} \sim \frac{\varepsilon \cdot c}{d}$$

a) Please calculate by taking the R_∞ value and the average particle size into account the absorption constant A in [cm^{-1}] at the wavelengths 450 and 600 nm!

b) Clarify by means of the Kubelka-Munk function, whether completely black or completely white substances may exit!

Task 4) (4 Points)

Temperature Dependent Spectroscopy

a) Describe the way to record a thermal quenching curve of a luminescent material 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!

Task 5) **(4 Points)**

Time Dependent Spectroscopy

a) Describe a practical way to record a decay curve of a luminescent material and to determine the decay time $\tau_{1/e}$ and $\tau_{1/10}$.

b) Sketch the decay curve of an emission process, which perfectly follows a first order kinetic (logarithmic y-axis)! How will the shape of the curve change, if a second relaxation process comes into play?