Examination

“Chemical Material Technology – Syntheses Techniques”

Date: March 23rd, 2018 **Max. 50 Points**

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

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

Task 1) (8 Points)

Solid State Reactions

a) Name the basic physical mechanism of solid state reactions and give an example of a typical solid state reaction! (2 Points)

b) Explain the role of defects in solid state reactions! (2 Points)

c) By which measure one can enhance the ion conductivity in the product phase of a solid state reaction to accelerate the overall reaction speed? (2 Points)

d) Sketch the defect density of an arbitrary solid state compound as function of temperature between 0 K and the melting point and mention the consequences for the choice of the reaction temperature! (2 Points)

Task 2) (6 Points)

Co-precipitation Reactions

a) Please name two advantages of the co-precipitation route for the synthesis of solid state materials! (2 Points)

b) Describe the synthesis of the scintillator $(Lu_{0.99}Pr_{0.01})_3Al_5O_{12}$ by using a co-precipitation process (starting materials shall be Lu_2O_3, Al_2O_3, and Pr_6O_{11})! (2 Points)

c) Give an example for a homogeneous precipitation process using urea! (2 Points)

Task 3) (4 Points)

Carbothermal Nitridation

Eu^{2+} doped silico nitrides are applied as red and green emitting luminescent materials in phosphor converted LEDs. For the synthesis of nitride hosts the carbothermal nitridiation is an established synthesis route. Balance the reaction equations for the synthesis of the following nitride hosts!

a) $CaCO_3 + SiO_2 + N_2 + C \rightarrow CaSiN_2$ (1 Point)

b) $SrCO_3 + Si_3N_4 + N_2 + C \rightarrow Sr_2Si_5N_8$ (1 Point)

c) $CaCO_3 + Al_2O_3 + Si_3N_4 + N_2 + C \rightarrow CaAlSiN_3$ (1 Point)

d) $SrCO_3 + Li_2CO_3 + Al_2O_3 + N_2 + C \rightarrow SrLiAl_3N_4$ (1 Point)

Task 4) (10 Points)

Chemical Transport Reactions

Halogen lamps comprise Iodine to enhance lifetime and energy efficiency with respect to conventional incandescent lamps.

a) Which chemical transport reaction is the basis of this performance improvement? (4 Points)

b) Explain by using the van't Hoff equation and a simple graph in which way the temperature determines the chemical equilibrium! Why takes a back transport from the glass bulb to the tungsten wire place? (4 Points)

c) Please mention two other technical application areas of Chemical Transport reactions! (2 Points)

Task 5) **(8 Points)**

Sol-Gel Chemistry

a) Explain the expressions “Sol” and “Gel”! (2 Points)

b) Sort the compounds $Si(OCH_3)_4$, $Si(OC_2H_5)_4$, $Si(OC_3H_7)_4$, and $Si(OC_4H_9)_4$ according to the speed of their hydrolysis! Please also explain your selected order! (2 Points)

c) Describe the hydrolysis of tetramethylorthosilicate in an acidic medium! (2 Points)

d) Describe the hydrolysis of tetramethylorthosilicate in an alkaline medium! (2 Points)

Task 6) (10 Points)

Inorganic Luminescent Pigments

a) Name a reaction pathway for the synthesis of the following inorganic luminescent pigments! (1 Point each)

ZnS:Mn

Y_2O_3:Eu

$Lu_3Al_5O_{12}$:Ce

YPO_4:Bi

$BaSi_2O_5$:Pb

b) Please mention for each of the aforementioned pigments a potential degradation mechanism! (1 Point each)

Task 7) (4 Points)

Nanoscale Inorganic Pigments

Please name two chemical methods

a) to synthesis nanoscale pigments (2 Points)

b) to stabilise nanoscale pigments in aqueous solution (2 Points)