Examination

"Chemical Material Technology – Syntheses Techniques"

Date: February 10th, 2017 **Max. 50 Points**

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

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

Task 1) (6 Points)

Solid State Reactions

a) Explain why reaction in the solid state take place only slowly in most cases! What can be done to enhance the reaction rate? (2 Points)

b) Sketch the formation of the spinel $MgAl_2O_4$ from the cubic starting materials Al_2O_3 and MgO? (2 Points)

c) Name two factors which determine the speed (constants) of a solid state reaction! (2 Points)

Task 2) (6 Points)

Solid State Synthesis Supported by Fluxes

a) Please name two relevant parameter for the selection of a flux to be used for the synthesis of a solid state compound such as $BaMgAl_{10}O_{17}$! (3 Points)

b) Please explain the role of Iodine for the fluxing of sulphides, such as CaS or SrS! (3 Points)

Task 3) (6 Points)

Carbothermal Nitridation

Eu^{2+} doped silico nitrides are applied as red, yellow and green emitting luminescent materials in phosphor converted LEDs. For the synthesis of respective nitride hosts the carbothermal nitridation is widely applied. Balance the reaction equations for the synthesis of the following nitride compounds!

a) $CaCO_3 + Si_3N_4 + N_2 + C \rightarrow Ca_2Si_5N_8$ (1 Point)

b) $SrCO_3 + Al_2O_3 + SiO_2 + N_2 + C \rightarrow SrAlSi_4N_7$ (1 Point)

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

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

e) $La_2O_3 + SiO_2 + N_2 + C \rightarrow La_3Si_6N_{11}$ (1 Point)

f) $BaCO_3 + SiO_2 + N_2 + C \rightarrow BaSi_2N_2O_2$ (1 Point)

Task 4) (6 Points)

Chemical Transport Reactions

Halogen (incandescent) lamps comprise Iodine or Bromine to enhance lifetime and energy efficiency with respect to conventional incandescent lamps.

a) Which chemical transport reaction is the basis of this performance improvement? (2 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)

Task 5) **(6 Points)**

Synthesis of Nanoscale Inorganic Pigments

Describe the following chemical techniques for the preparation of nanoscale particles by using a respective example!

a) Polyol method (2 Points)

b) Microemulsion technique (2 Points)

c) Pechini method (2 Points)

Task 6) (6 Points)

Gas Phase Processes

a) Explain the term chemical vapor deposition (CVD)? (2 Points)

b) Semiconductor LEDs are epitactically grown by CVD. Please name the reaction equation for the production of an (Al,In,Ga)P layer!

c) Define the term fluid bed (FB) CVD and name an application area! (2 Points)

Task 7) (6 Points)

Hydrothermal Synthesis

a) Sketch a reactor system for the hydrothermal growth of Quartz crystals (4 Points)

b) By which chemical measure one can enhance the speed of the hydrothermal growth of Quartz and Ruby crystals? (2 Points)

Task 8) (8 Points)

Luminescent Pigments

a) Many different kind of loss processes reducing the photoluminescence efficiency of luminescent pigments can occur during the absorption, energy transfer and the emission process. Give an example for a common loss process during all three steps of the energy flow! (3 Points)

b) By which technical measures one can improve the long-term stability of luminescent pigments? Give two examples! (2 Points)

c) A 100 g sample of $BaMgAl_{10}O_{17}$:Eu ($\rho(BaMgAl_{10}O_{17})$ = 3.8 g/cm^3), which consists of monodisperse spherical particles with a diameter of 5 µm shall be coated by MgO. Calculate the required amount of MgO to coat all particles by a dense and 50 nm thick coating layer (ρ(MgO) = 3.58 g/cm^3). How much $Mg(NO_3)_2$ is required as precursor for the $Mg(OH)_2$ precipitation? (3 Points)