Examination

"Chemical Material Technology – Syntheses Techniques"

Date: September 28th, 2017 **Max. 50 Points**

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

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

Task 1) (9 Points)

Solid State Compounds

Give two examples each for the following classes of solid state compounds! (each completed box yields 1 Point)

	Binary	Ternary	Quaternary
Fluorides			
Sulphides			
Nitrides			

Task 2) (8 Points)

Solid State Reactions

a) Which physical process is in general the basis of solid state reactions? (1 Point)

b) Please name two intrinsic measures and two extrinsic measures to accelerate the speed of a solid state reaction! (4 Points)

c) Please sketch a figure to illustrate the effect of a halide flux on the speed of a solid state reactions of oxides! (3 Points)

Task 3) **(5 Points)**

Solid State Reactions

Please balance the following reaction equations! (each 1 Point)

a) $CaCO_3 + AlN + Si_3N_4 + N_2 + H_2 \rightarrow CaAlSiN_3 + H_2O + CO$

b) $SrCO_3 + SiO_2 + C + N_2 \rightarrow Sr_2Si_5N_8 + CO$

c) $Gd_2O_3 + MgO + H_3BO_3 \rightarrow GdMgB_5O_{10} + H_2O$

d) $NH_4H_2PO_4 + Lu_2O_3 \rightarrow LuPO_4 + H_2O + NH_3$

e) $Tb_4O_7 + MgO + H_3BO_3 + CO \rightarrow TbMgB_5O_{10} + CO_2 + H_2O$

Task 4) (8 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? (4 Points)

b) Please 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) **(12 Points)**

Inorganic Luminescent Pigments

a) An inorganic luminescent pigment consists of a host compound doped by one or several activator ions, impurity ions, and defects. Explain the role of each component for the optical properties of a luminescent pigment, e.g. for $BaMgAl_{10}O_{17}$:EuMn! (4 Points)

Activator: Eu^{2+}
Co-Activator: Mn^{2+}
Impurity: Fe^{3+}
Defects Oxygen vacancies

b) Loss mechanisms occur in all steps of the energy flow in a luminescent material: The reduction of the quantum efficiency of a luminescent material is observed either if the absorbed energy does not reach the activator ion, or if the absorbed energy reaches the activator ion, but non-radiative channels exists at the cost of radiative return to the ground state, or if the emitted radiation is re-absorbed by the luminescent material.
Give an example for a relevant physical loss mechanism during all three steps of the energy flow! (3 Points)

c) By which technical measures one can improve the long-term stability of a luminescent pigment, e.g. in inorganic LEDs (2 Points)

d) Please mention for the following luminescent pigments a potential degradation mechanism! (3 Points)

$CaS:Eu^{2+}$

$K_2SiF_6:Mn^{4+}$

$Y_3Al_5O_{12}:Ce^{3+}$

Task 6) (8 Points)

Nanoscale Inorganic Pigments

Nowadays, nanoscale inorganic pigments find numerous technical applications, e.g. for the coating of lamp and display glass, for particle coatings or as additives in suspensions or printing pastes.

a) Describe two chemical or physical techniques to synthesize nano scale inorganic oxides! (4 Points)

b) Please name two chemical or physical properties, which make a difference between nano and micro scale materials! Explain the cause for these differences too! (4 Points)