Examination

"Chemical Material Technology – Syntheses Techniques"

Date: March 10th, 2022 **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			
Oxides			
Nitrides			

Task 2) (8 Points)

Solid State Reactions

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

b) Please name four measures to accelerate the speed of a solid state reaction! (4 Points)

c) Please sketch a figure to illustrate the effect of a fluoride type 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) $Eu_2O_3 + MgCO_3 + Al_2O_3 + H_2 \rightarrow EuMgAl_{10}O_{17} + CO_2$

d) $NH_4H_2PO_4 + La_2O_3 \rightarrow LaPO_4 + H_2O + NH_3$

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

Task 4) (8 Points)

Chemical Transport Reactions

In halogen incandescent lamps Iodine or Bromine is added 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 $LaPO_4$:Ce,Tb! (4 Points)

Activator: Tb^{3+}
Sensitizer: Ce^{3+}
Impurity: Cr^{3+}
Defects Oxygen vacancies

b) Loss mechanisms occur in all steps of the energy flow in a luminescent material: The reduction of 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 luminescent pigments in application? (2 Points)

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

$BaMgAl_{10}O_{17}:Eu^{2+}$

$K_2SiF_6:Mn^{4+}$

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

Task 6) **(8 Points)**

Nanoscale Inorganic Pigments

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 a chemical way to synthesize nanoscale particles of Gold ! (2 Points)

b) Mention a technique and give the respective reaction equation for the synthesis of nanoparticles of SiO_2 and Al_2O_3! (4 Points)

c) Please name two ways to separate nanoscale from microscale particles! (2 Points)