

## Examination

### “Chemical Material Technology – Syntheses Techniques”

Date: March 10<sup>th</sup>, 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)

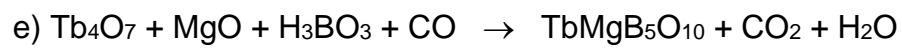
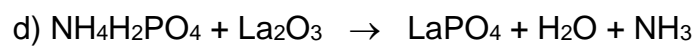
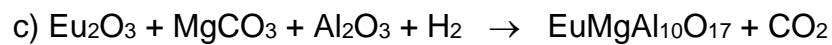
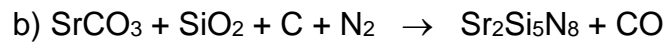
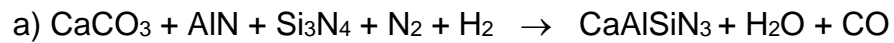
(8 Points)

### 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)



**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  $\text{LaPO}_4:\text{Ce},\text{Tb}$ ! (4 Points)

Activator:  $\text{Tb}^{3+}$   
Sensitizer:  $\text{Ce}^{3+}$   
Impurity:  $\text{Cr}^{3+}$   
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 exist 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)

$\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$

$\text{K}_2\text{SiF}_6:\text{Mn}^{4+}$

$\text{Y}_3\text{Al}_5\text{O}_{12}:\text{Ce}^{3+}$

**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  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$ ! (4 Points)
- c) Please name two ways to separate nanoscale from microscale particles! (2 Points)