

# Óbuda University

Doctoral School of Materials Sciences and Technologies

Hun-Ren, Centre for Energy Research,  
Institute of Technical Physics and Materials Science



## ***Development and structural characterization of Calcium silicate porous ceramics***

**PhD student :**

Maroua Houria Kaou

**Supervisors:**

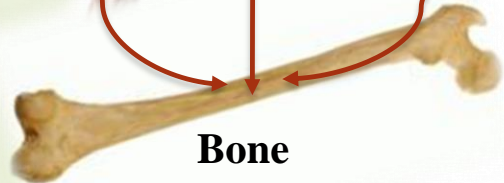
Dr. Csaba Balázs

Dr. Katalin Balázs



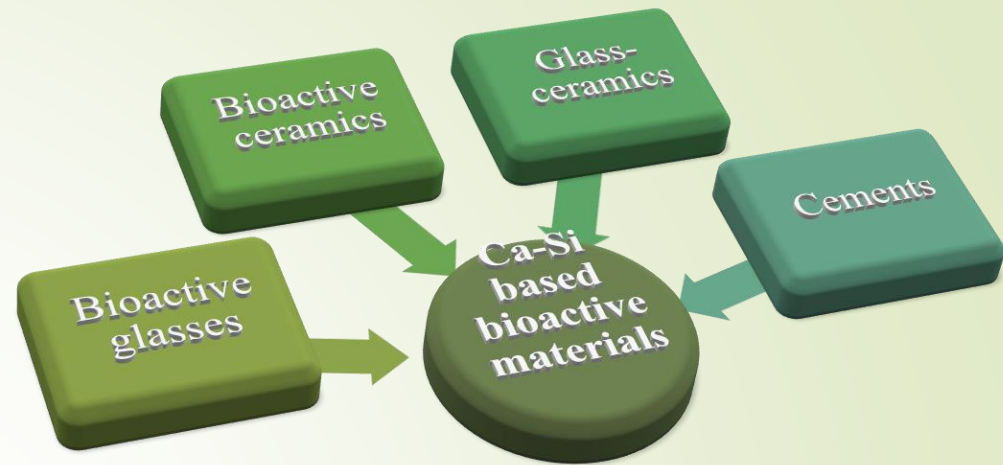
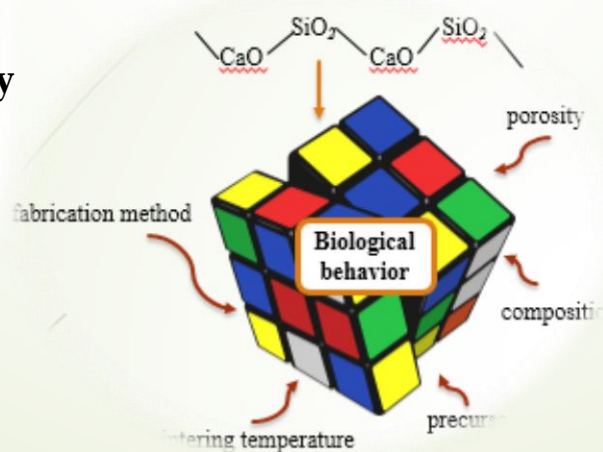
# Recall from the previous semesters

## Calcium Silicates ( $CaO-SiO_2$ )



**Bone**

**Protects the organs inside the body**  
**Provides mechanical support,**  
**haematopoiesis, mineral storage**  
**Mobility.**  
**Self healing ability**



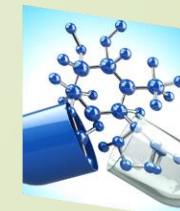
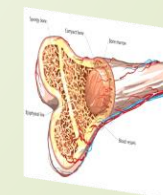
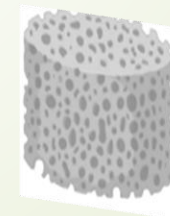
**Promising material**

Formation of an apatite layer



**$CaO-SiO_2$  ceramics**

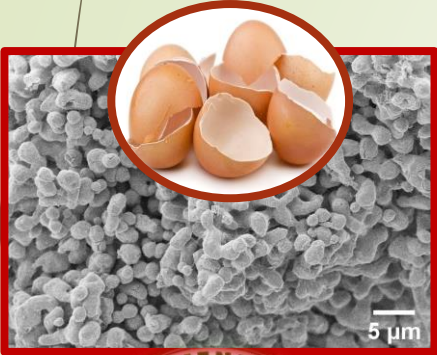
**Excellent bioactivity**  
**Good biocompatibility**





# Flashback on the preparation process

CaO



Heat Treatment  
(12h, 900 °C)  
Milled silica



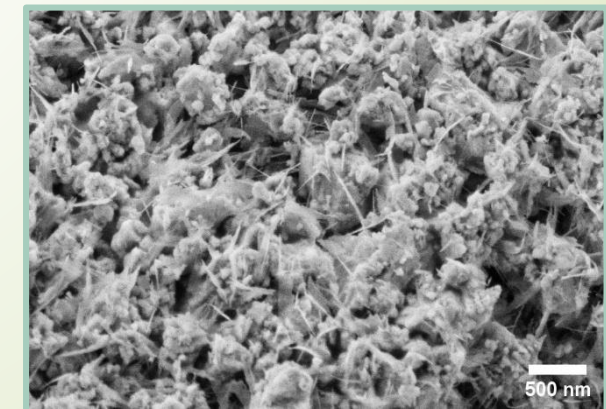
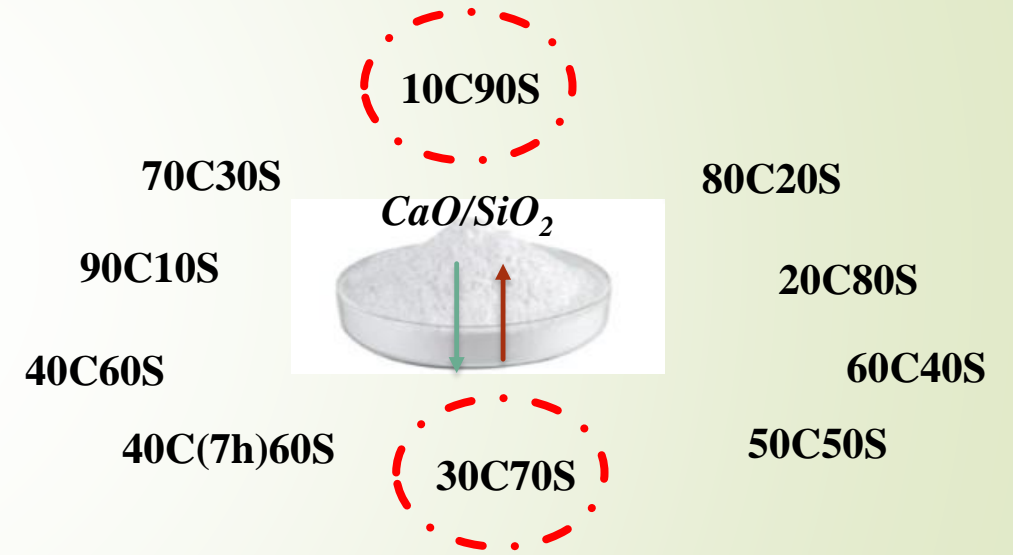
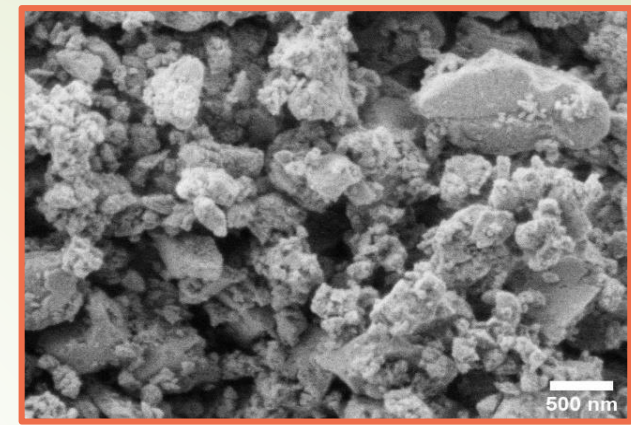
Ball Milling (3h, 10 balls of alumina)



Drying at 151°C and sieving with a mesh size of 100 μm



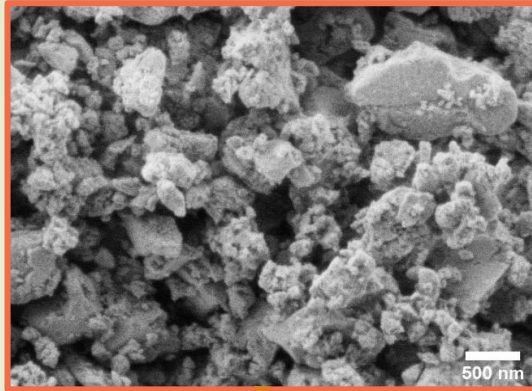
Attrition milling for 3h in ethanol ( at 2000 rpm for 2.5h) followed by the addition of PEG (500 rpm for 0.5h)





# Preparation of ceramic discs

10C90S



Calcium silicate  
powders

Pressing (Dry, RT)



Pressing (180 bars)

Pressing (200 bars)



Green samples



Heat treatment (Air, 800° C, 1h)

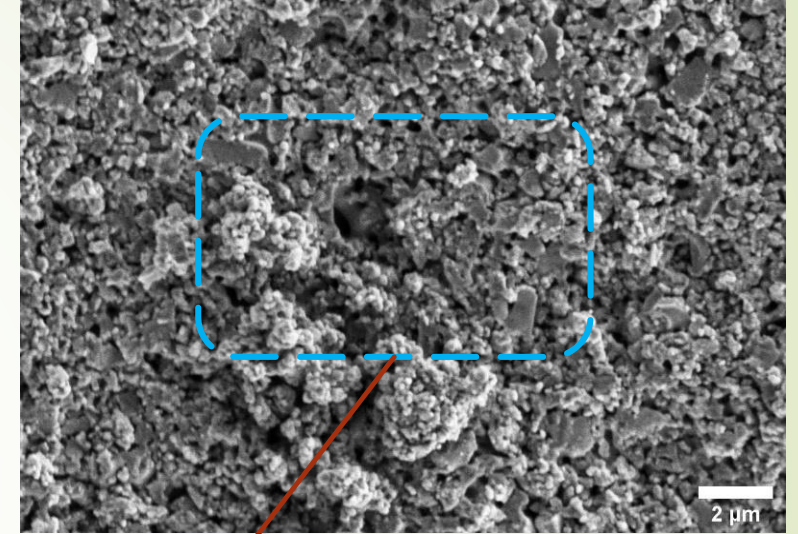
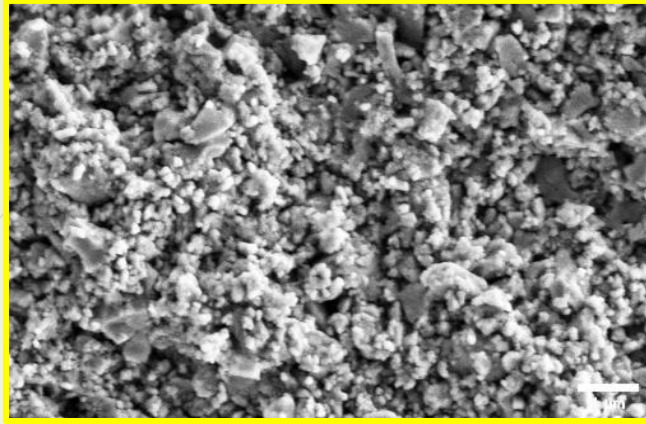




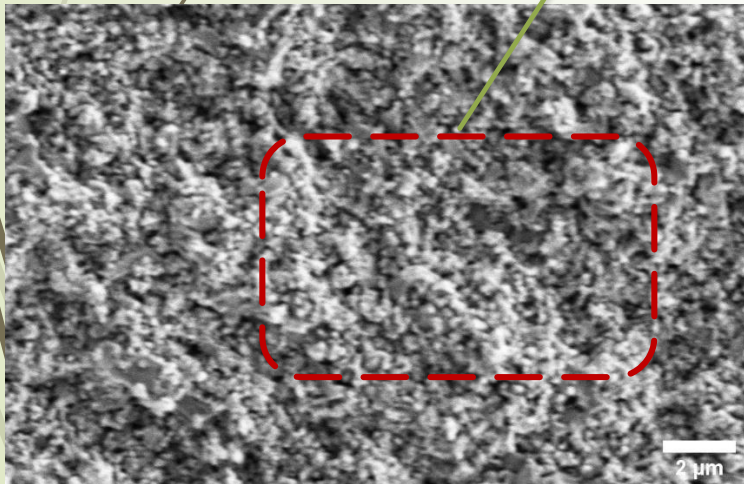
# Morphological investigation of ceramics

(200 bars)

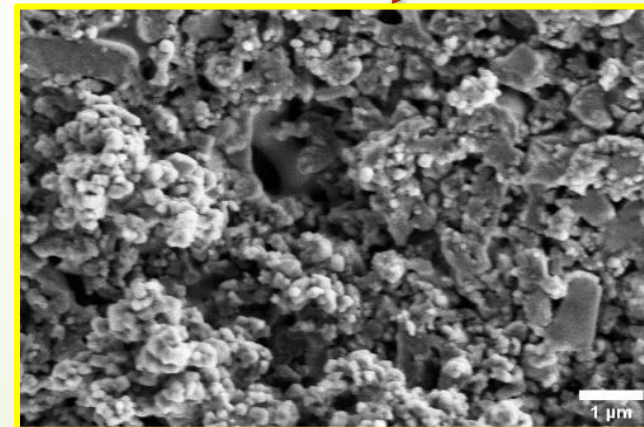
30 wt% CaO /70 wt% SiO<sub>2</sub>



(200 bars)



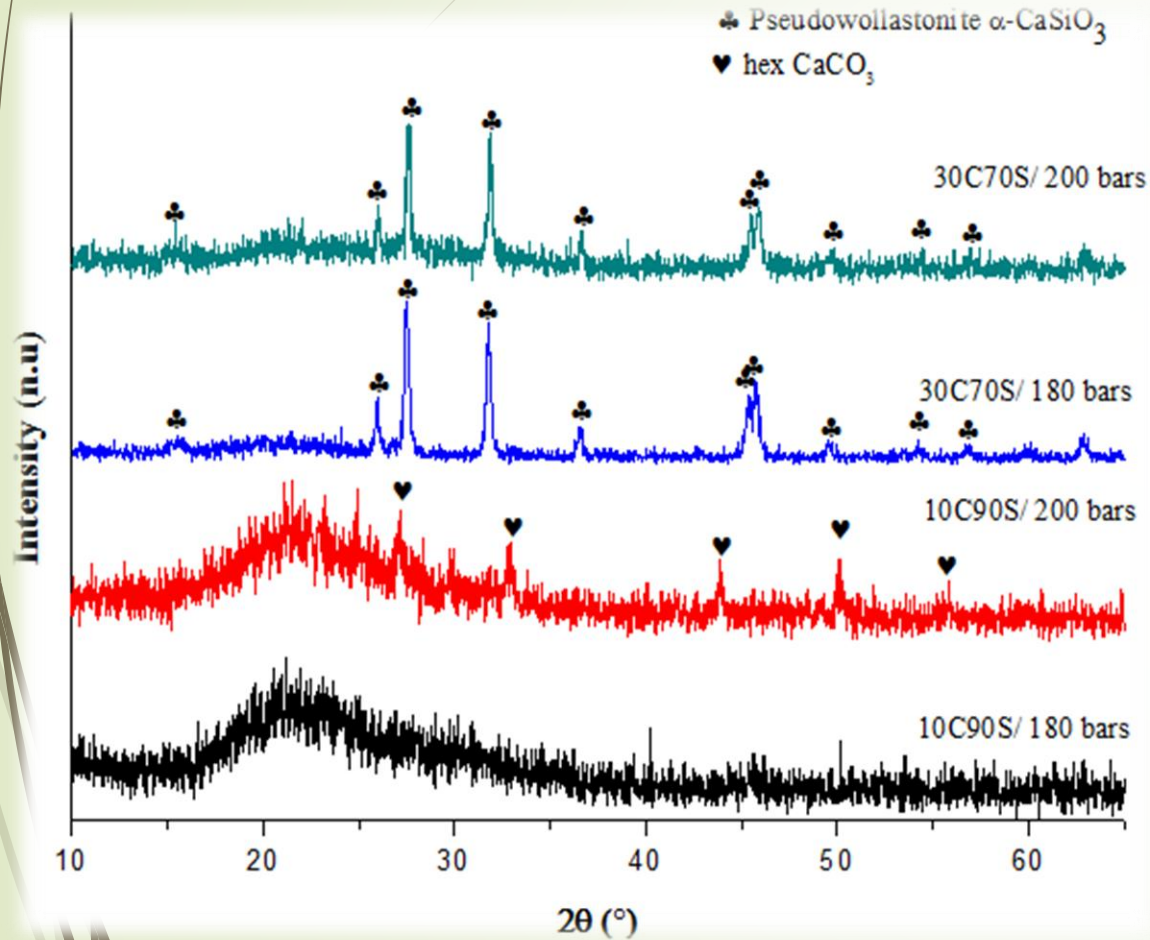
10 wt% CaO /90 wt% SiO<sub>2</sub>





# Effect of pressure

## Structural investigation of ceramics, density measurements



XRD patterns of calcium silicate ceramics

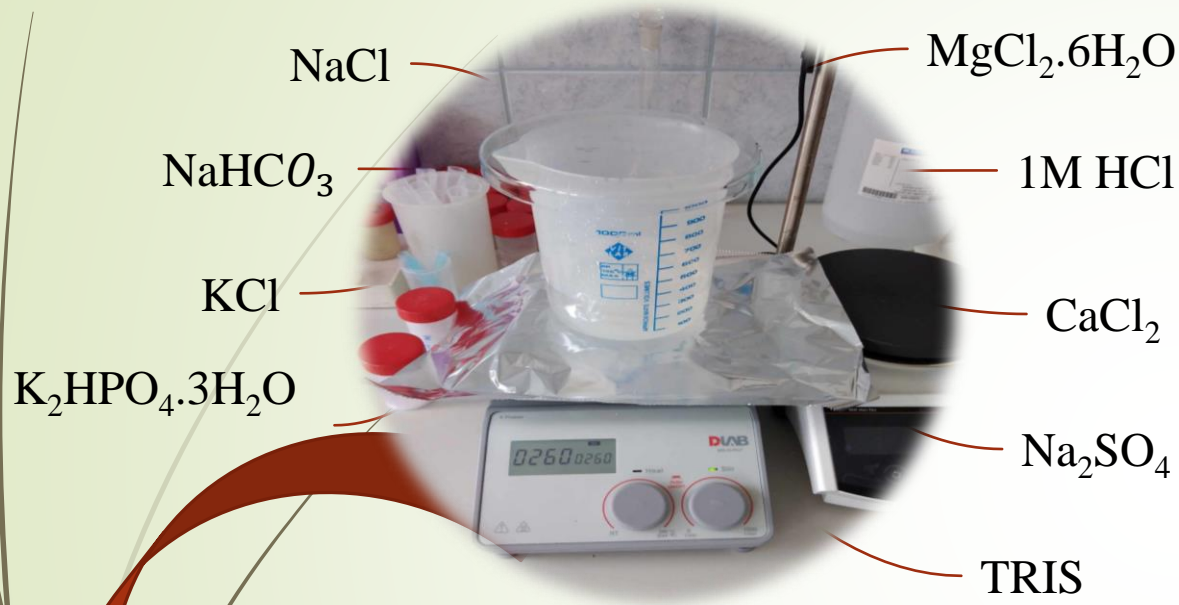
Composition	10C90S	30C70S
Apparent density (g/cm <sup>3</sup> )/ P= 180 bars	1.509	1.801
Apparent density (g/cm <sup>3</sup> )/ P= 200 bars	1.621	1.854

Density measurements



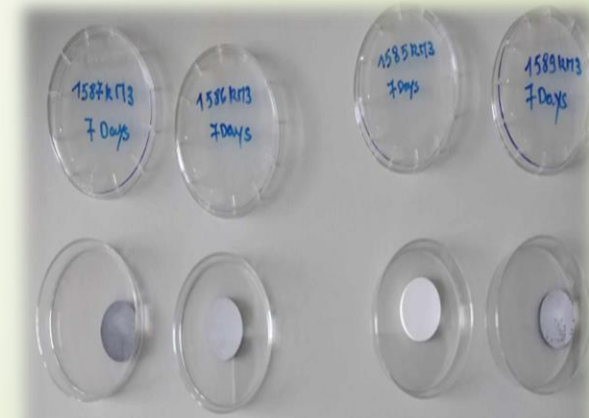
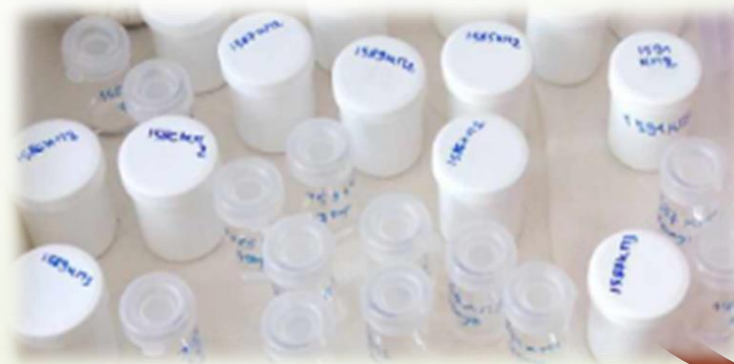
# SBF solution test

## SBF solution preparation



pH	pH (0 days)	pH (7 days)	pH (14 days)
<b>Composit ion</b>			
<b>10C90S</b>	7.4	8.66	8.86
<b>30C70S</b>	7.4	8.41	8.57

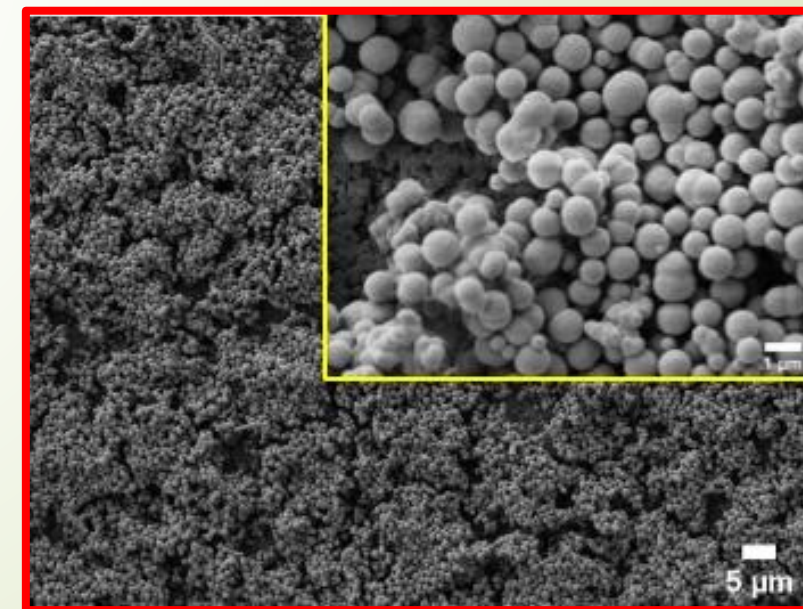
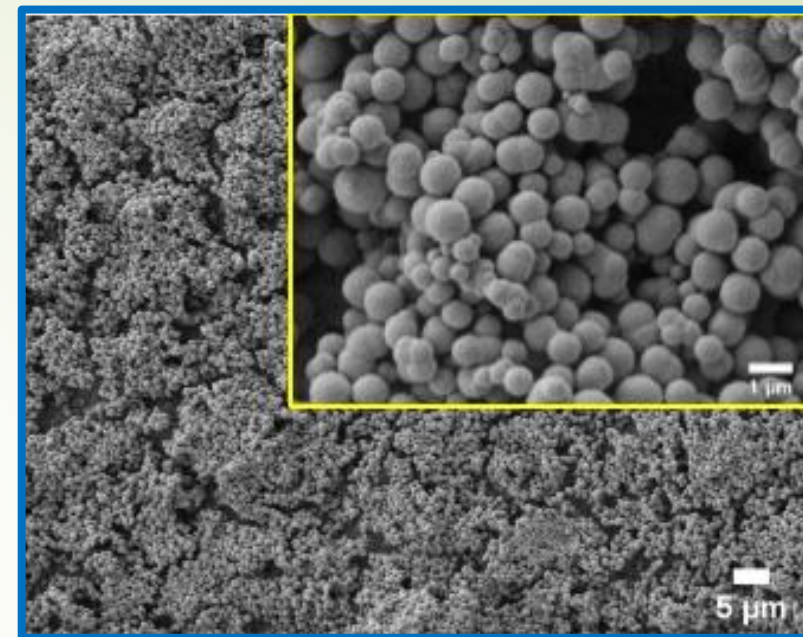
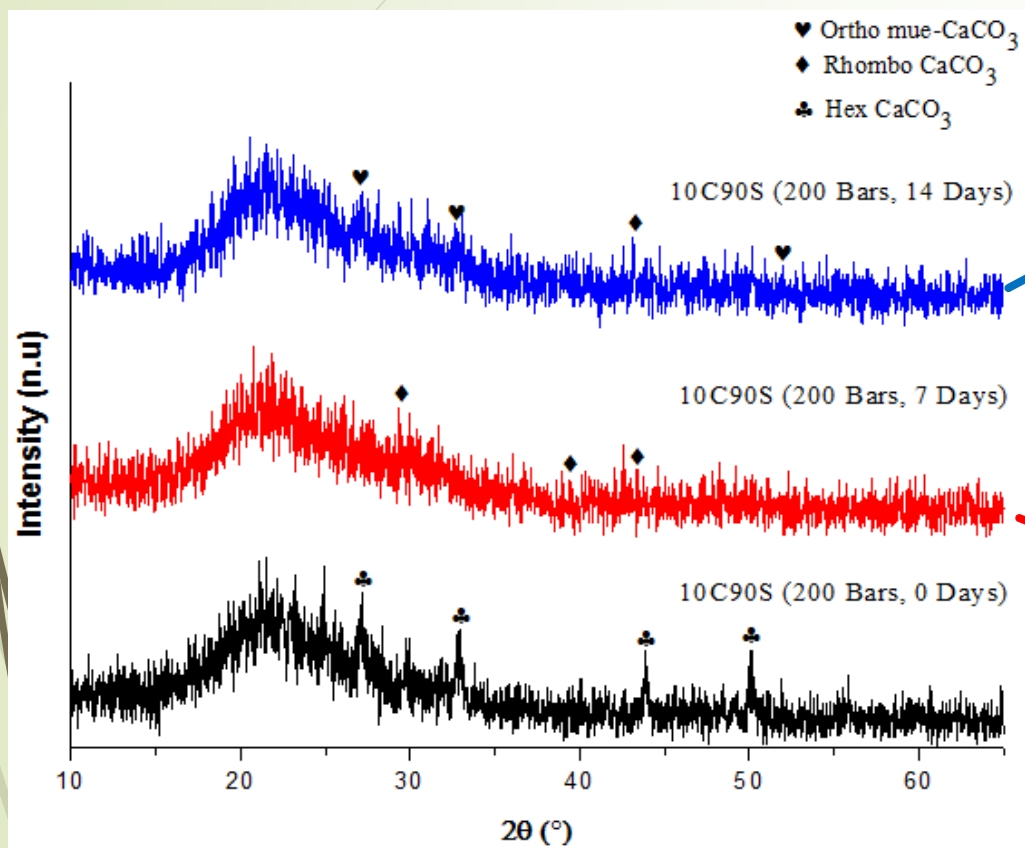
pH evaluation of 10C90S and 30C70S





# Structural investigation of immersed samples

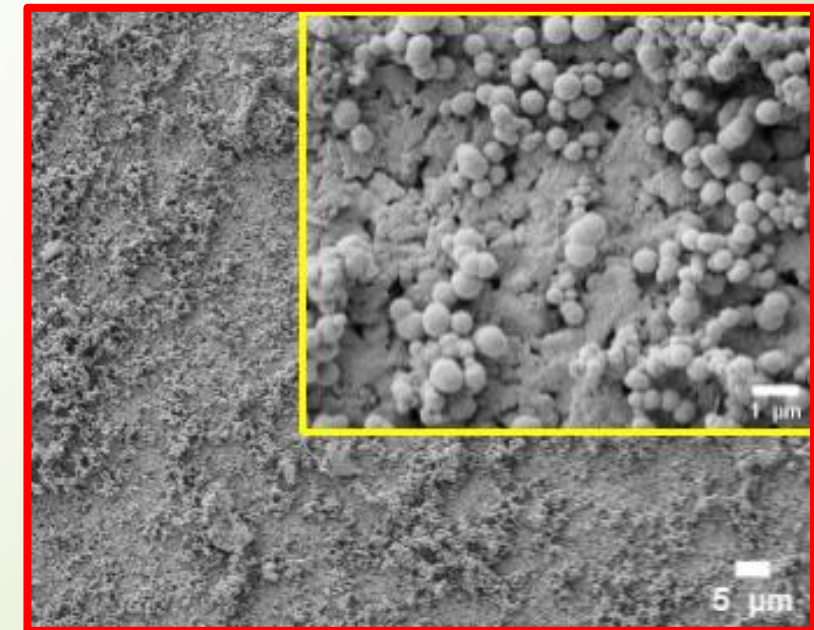
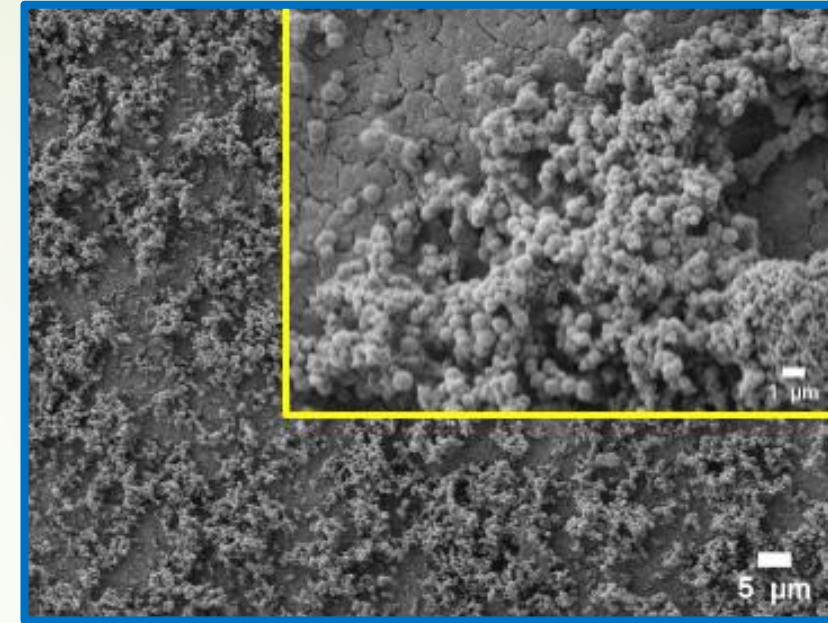
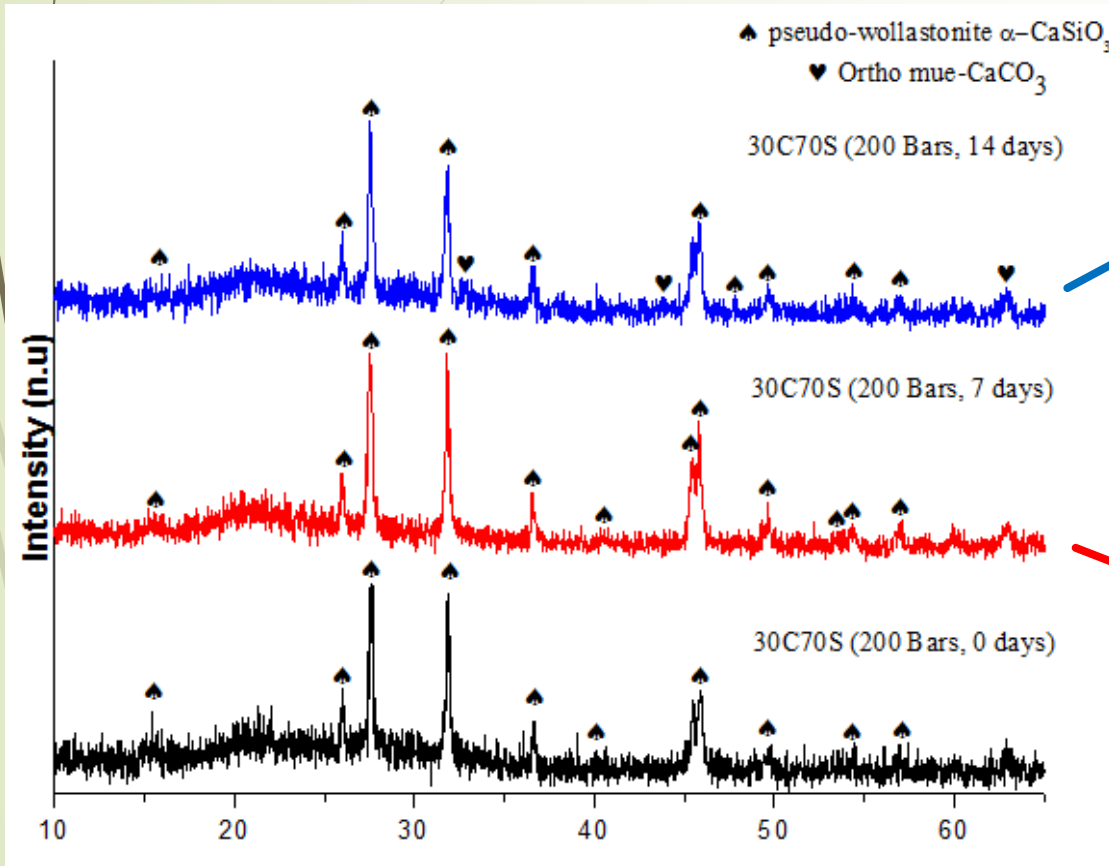
10 wt% CaO /90 wt% SiO<sub>2</sub>





# Structural investigation of immersed samples

30 wt% CaO /70 wt% SiO<sub>2</sub>





# Results

## **1. Semester:**

- 1) Powder technology (Dr. Balázs C.)
- 2) Biomaterials for medical applications (Dr. Balázs C.)

## **3. Semester:**

- 1) Fracture mechanics (Dr. Kovács T. A)
- 2) Composites (Dr. Klébert Sz.),
- 3) Hungarian II (Dr. Szloboda József Sándorné K.)

## **2. Semester:**

- 1) Transmission electron microscopy for structural investigations of different materials (Dr. Balázs K.)
- 2) Selected chapters of material testing methods I. (Dr. Takács E, Dr. Judit Telegdi)
- 3) Hungarian I (Dr. Szloboda József Sándorné K.)

## **4. Semester:**

- 1) Cellulose chemistry (Dr. Borsa Judit)
- 2) Synthetic fibres and textiles (Dr. Borsa Judit)



# Presentations and publications

## **Publications:**

**[1] Kaou, Maroua H.; Horváth, Zsolt E.; Balázs, Katalin; Balázs, Csaba. Eco-friendly preparation and structural characterization of calcium silicates derived from eggshell and silica gel. INTERNATIONAL JOURNAL OF APPLIED CERAMIC TECHNOLOGY 20: 2 pp. 689-699, 11 p. (2023).**

**[2] Kaou, Maroua H.; Furkó, Mónika ; Balázs, Katalin ; Balázs, Csaba. Advanced Bioactive Glasses: The Newest Achievements and Breakthroughs in the Area. NANOMATERIALS 13: 16 Paper: 2287, 33 p. (2023).**

**[3] Kaou, Maroua H.; Furkó, Mónika ; Balázs, Katalin ; Balázs, Csaba. Morphological and structural evaluation of spark plasma sintered calcium silicate ceramics. INTERNATIONAL JOURNAL OF APPLIED CERAMIC TECHNOLOGY in press p. in press , 13 p. (2024)**

## **Conferences:**

- 1) Participated in [Virtual] European Congress and Exhibition On Advanced Materials and Progress - (EUROMAT 2021), September 12-16 (Poster).**
- 2) Participated in [Virtual] 46th international Conference and Exposition on Advanced Ceramics and Composites (ICACC 2022), January 23-28 (Poster).**





# Presentations, publications and research plan

## Conferences:



- 3) Participated in **Ceramics In Europe (ECerS 2022)** conference, July 10-14 (Poster).
- 4) Participated in [Virtual] **ACerS Pan American Ceramics Congress (PACC-FMAs 2022)**, July 24-28 (Poster).
- 5) Participated in **International Hybrid Conference on Nano Structured Materials and Polymers (ICNP)**, May 12-14 (Invited talk, virtual).

## Next steps:

- ✓ Continue writing my last 2 papers and submit them.
- ✓ Continue writing my PhD thesis.

*Thank you for your attention!*

