

# SYNTHESIS OF MONETITE PLATELETS FOR COMPOSITE BONE GRAFT SUBSTITUTES

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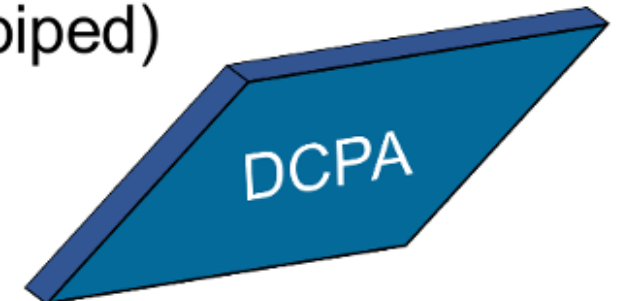
## Motivations

The self-healing ability of bone is only sufficient to repair small defects. For large defects, surgical intervention and implantation of a bone graft may be required. The main challenge for such material is to combine biocompatibility, resorbability and load-bearing properties<sup>1</sup>. This could be done by mimicking the nacre structure<sup>2</sup>, but there are two issues: produce the ceramic platelets and organize them into the matrix in an ordered manner.

## Aims

The general aim of this project was to improve the synthesis of monetite (DCPA) platelets used as reinforcements in chitosan-monetite composite with<sup>2</sup>:

- Controlled geometry (parallelepiped)
- Narrow size dispersion,
- High aspect ratio (up to 20),
- No agglomerates

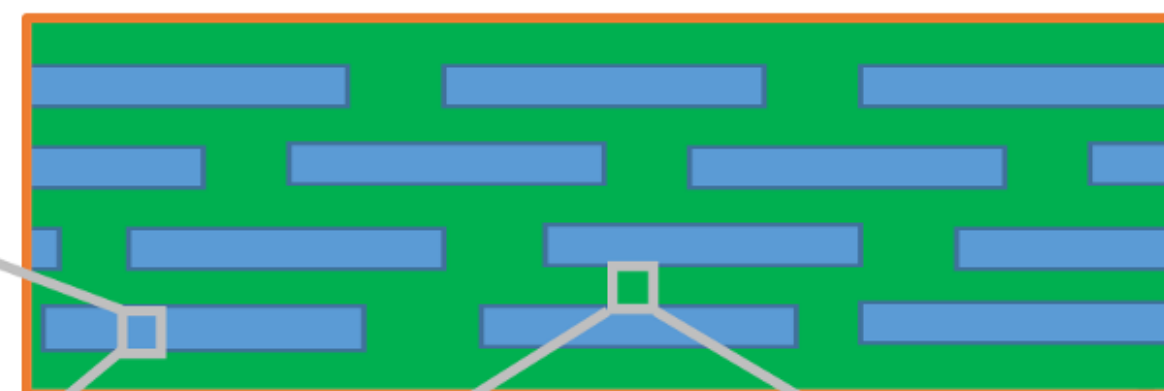
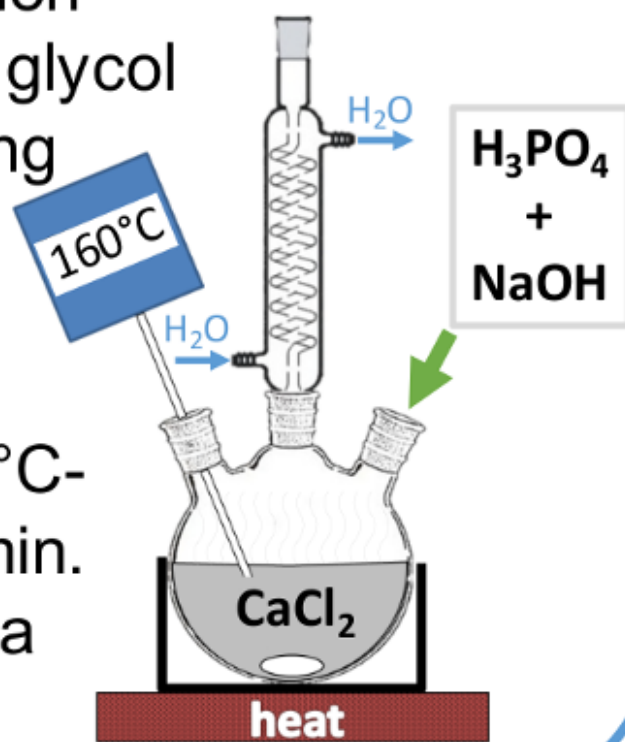


## Materials and methods

### Monetite Platelets

#### 1. Synthesis in batch

**reactor:** precipitation from two ethylene glycol reagents, containing respectively  $\text{CaCl}_2$  and  $\text{H}_3\text{PO}_4$ ; **Temperature:** maintained at 100°C-170°C during 90 min. **pH:** adjusted with a NaOH solution.



### Chitosan

**2. Dissolution:** Chitosan from crab shells mechanically stirred in 0.1 M acetic acid solution during 24 hours.

### Chitosan-Monetite Composite

**3. Mixing:** Chitosan solution with monetite platelets

**4. Casting** in glass petri dishes moulds

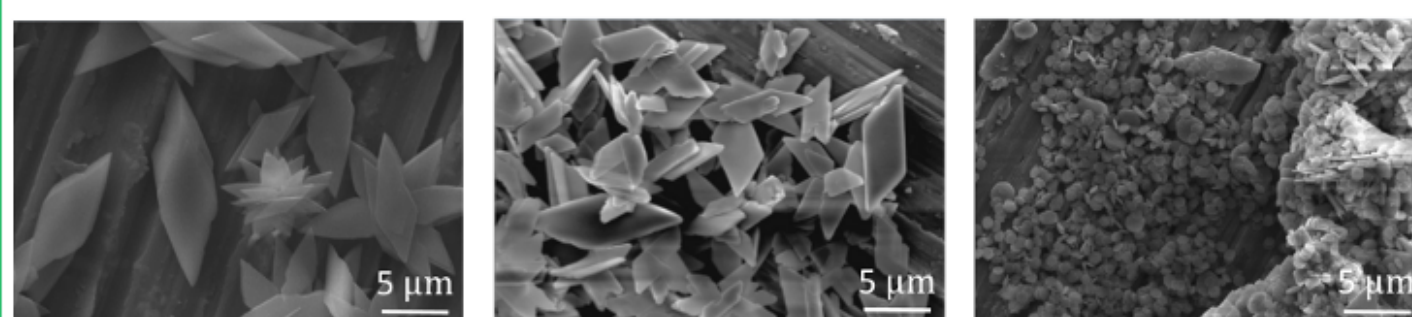
**5. Degassing:** Combination of vacuum and addition of ethanol on the top surface of the mould to accelerate air bubble removal.

**6. Solvent evaporation:** 3 days in a climate chamber at 30°C and 70% RH

## Results and discussion

### 1. Influence of pH

Acidic Basic

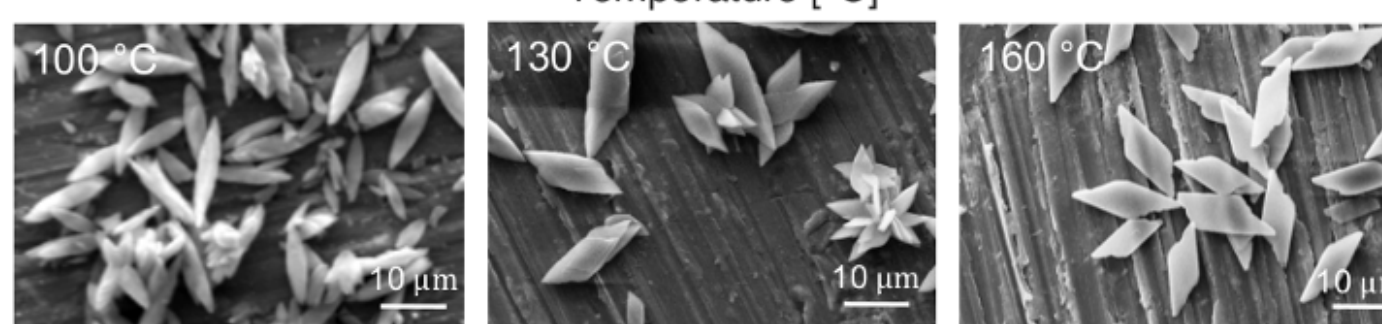
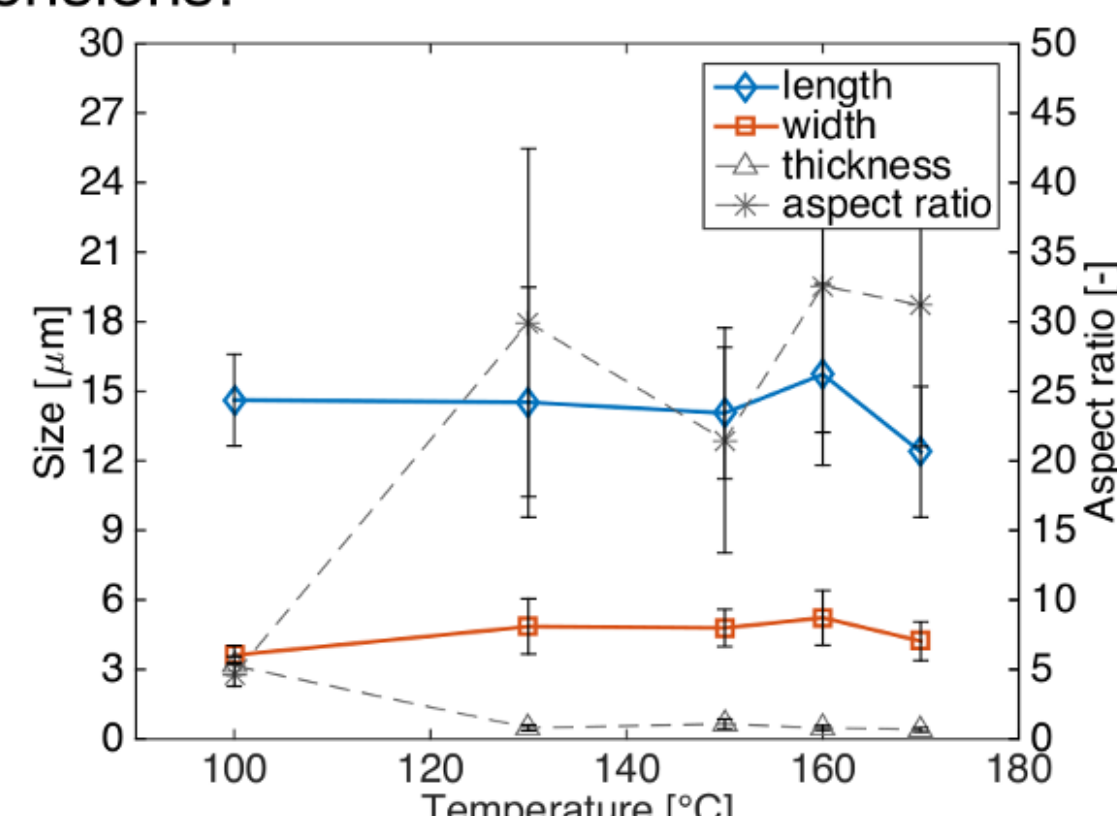


3D clusters with few platelets      Platelets (fairly large size distribution)       $\beta$ -TCP and/or Na-P precipitation

The pH was tuned by the NaOH concentration in solution. Large amounts of 3D clusters were observed at low pH whereas at high pH presence of other phases was noticed (namely  $\beta$ -TCP). In neutral conditions, parallelepiped platelets with few 3D clusters were obtained.

### 2. Influence of Temperature

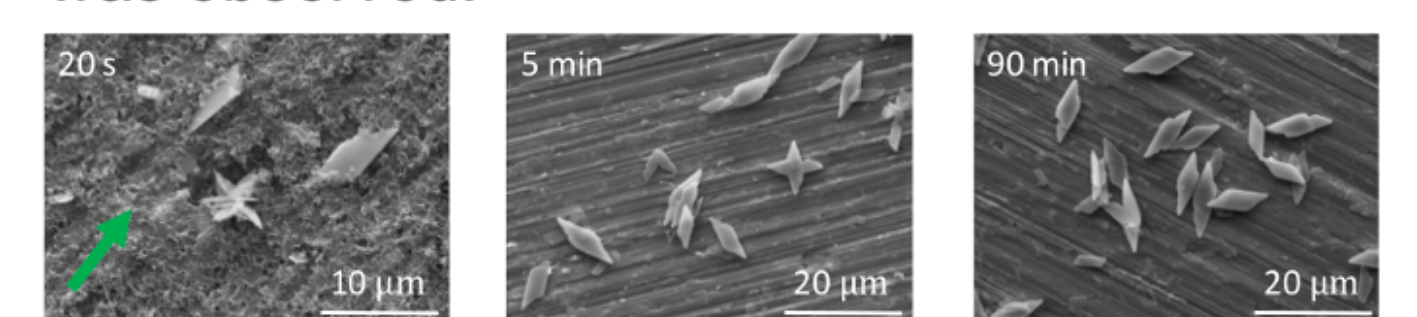
The temperature was found to affect mainly the shape of monetite platelets and less their dimensions.



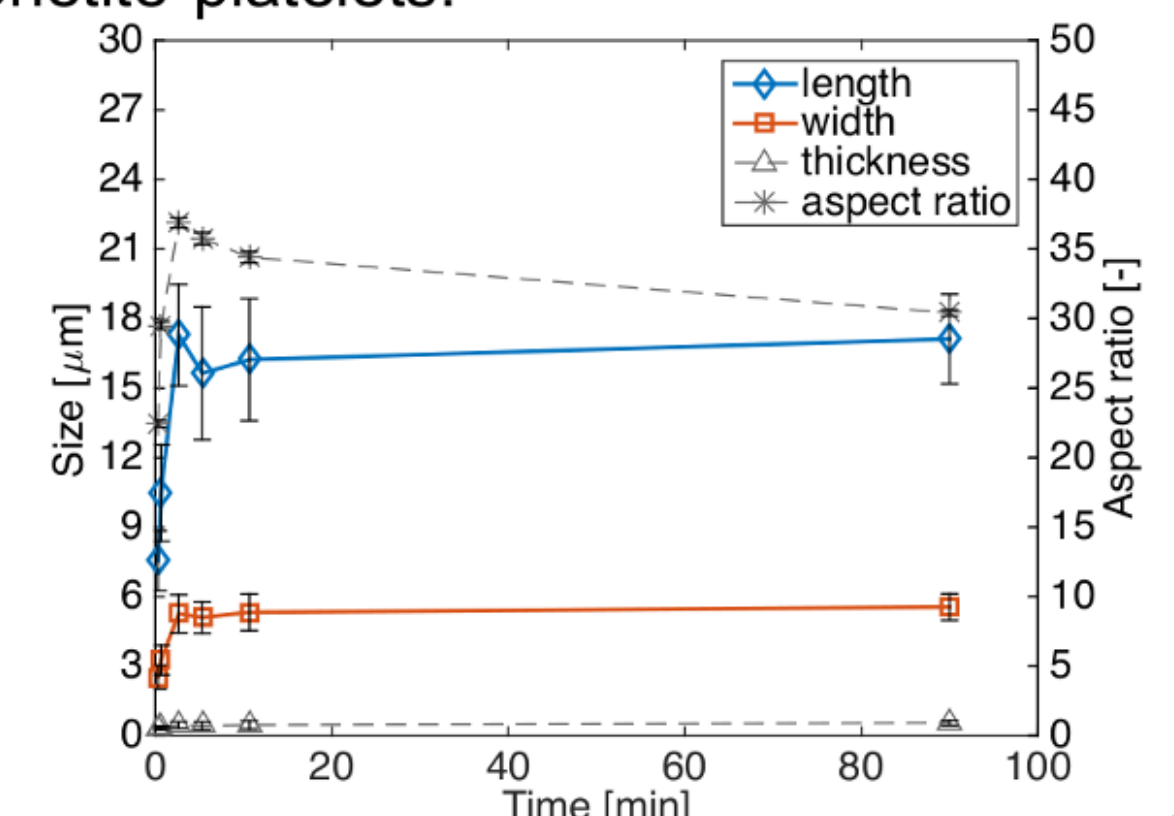
Thick layered platelets      3D clusters and parallelepiped platelets      Parallelepiped platelets

### 3. Kinetic Study

At 20s of reaction time, coexistence of an amorphous phase with monetite platelets was observed.

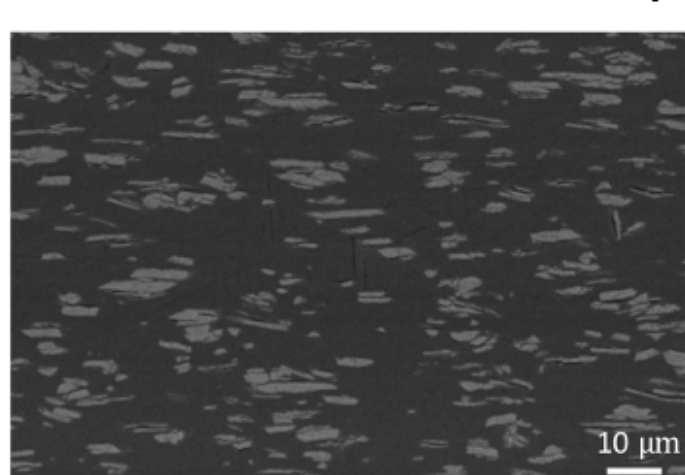


After 5 min, this amorphous phase was completely resorbed, leading the place to monetite platelets.

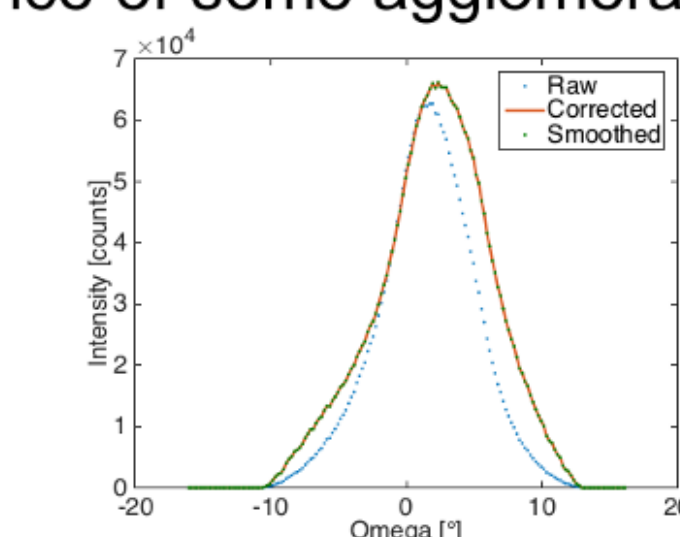


## Application

Chitosan-monetite (15 vol%) composite were feasible and revealed a good orientation of the platelets with a mean value of  $9.3 \pm 0.7^\circ$  and presence of some agglomerates.



Composite cross-section



Rocking curve measurement

## Conclusion

Syntheses conducted at 160°C, in neutral conditions, with a Ca/P ratio of 1.5 and a total precursor concentration of 32mM for at least 5 min, appeared as the best compromise between all the different syntheses investigated herein.

## References

- 1 Laetitia Galea et al., Biomaterials. 34 (2013) 6388-401.
- 2 Laetitia Galea PhD thesis, Technische Universität Bergakademie Freiberg, 2015.

## Acknowledgments

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