Development of Composite Biomaterials Based on Calcium Polyphosphate, Alginate, and Magnesium for Bone Tissue Applications

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INTRODUCTION

Hydroxyapatite (HAp), $Ca_{10}(PO_4)_6(OH)_2$, is an inorganic matrix that is the main constituent of bone tissue. Chemically, HAp has similarities with many phosphate salts. Thus, many studies use these salts to develop novel and optimized scaffolds for bone applications.[1] Calcium polyphosphate (CPP) presents the potential for bone replacements due to its biocompatibility and lower toxicity.[2] Nevertheless, to obtain good mechanical properties, it is necessary to associate CPP with polymers, such as alginate (Alg). Alginate is a natural polymer, without toxicity, that has been widely used in biomedical applications.[3] Other additives can be introduced in CPP to improve its properties, such as Mg^{2+} ions. These ions participate in mechanisms that are involved in bone calcification and decalcification.[4]

In this context, this work presents the development of a composite based on CPP, alginate, and Mg^{2+} ions, as candidates for bone applications.

METHODOLOGY

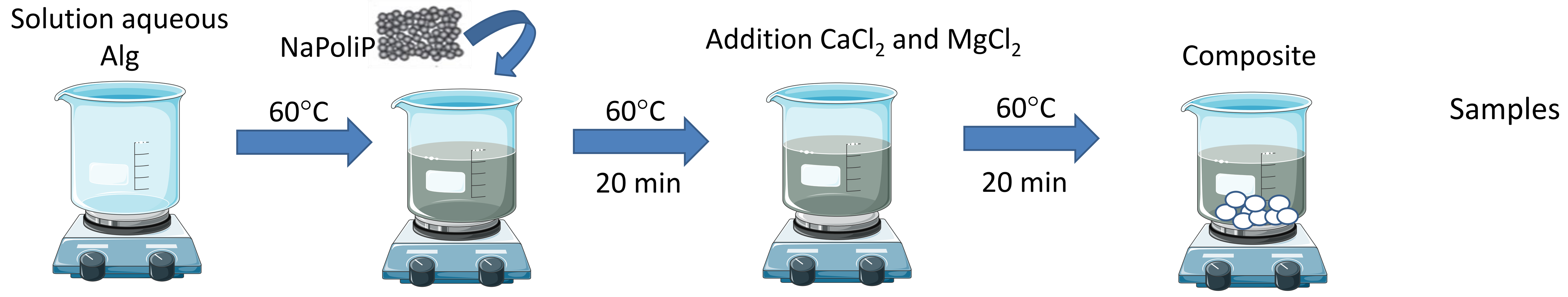

Figure 1. Esquematization of the methodology used to prepare the composite materials.

RESULTS

The precipitation of calcium polyphosphate is based on the reaction (1) under heating of 60°C.

Reaction (1):

$$m\,Ca^{2+}(aq) + (PO_3^-)_n(aq) \rightarrow Ca_m(PO_3)_n(s)$$

- **ATR-FTIR**

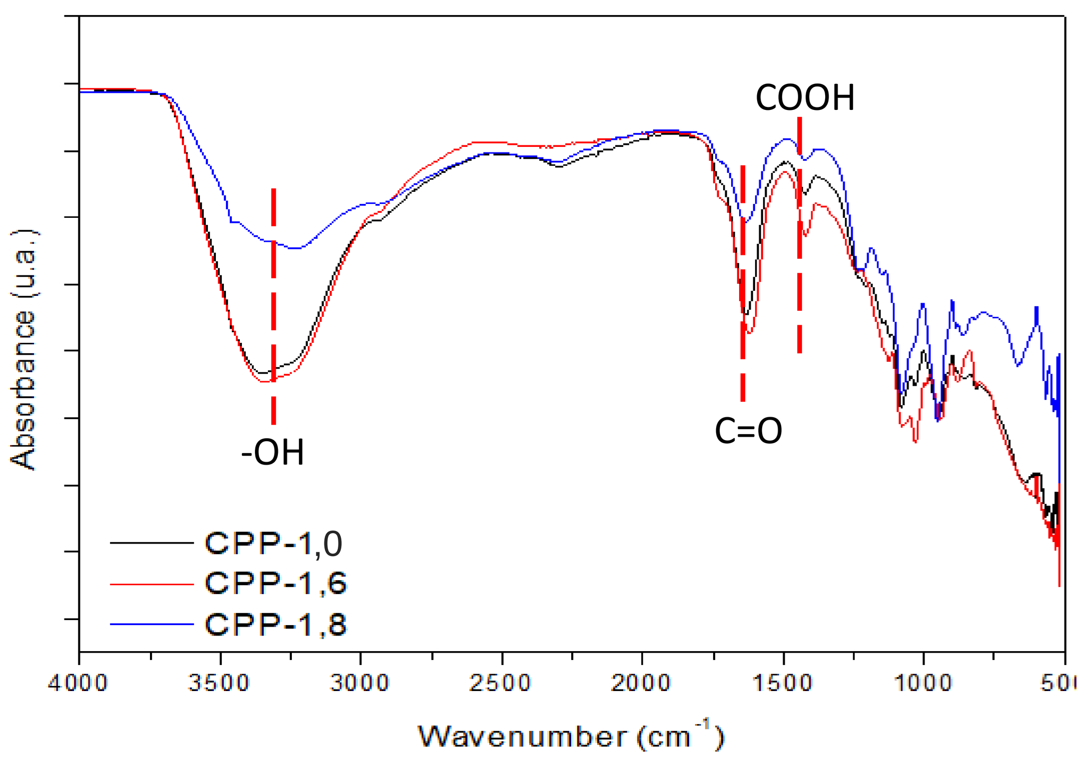

Figure 2. ATR-FTIR spectrum of various composite materials.

- **Raman**

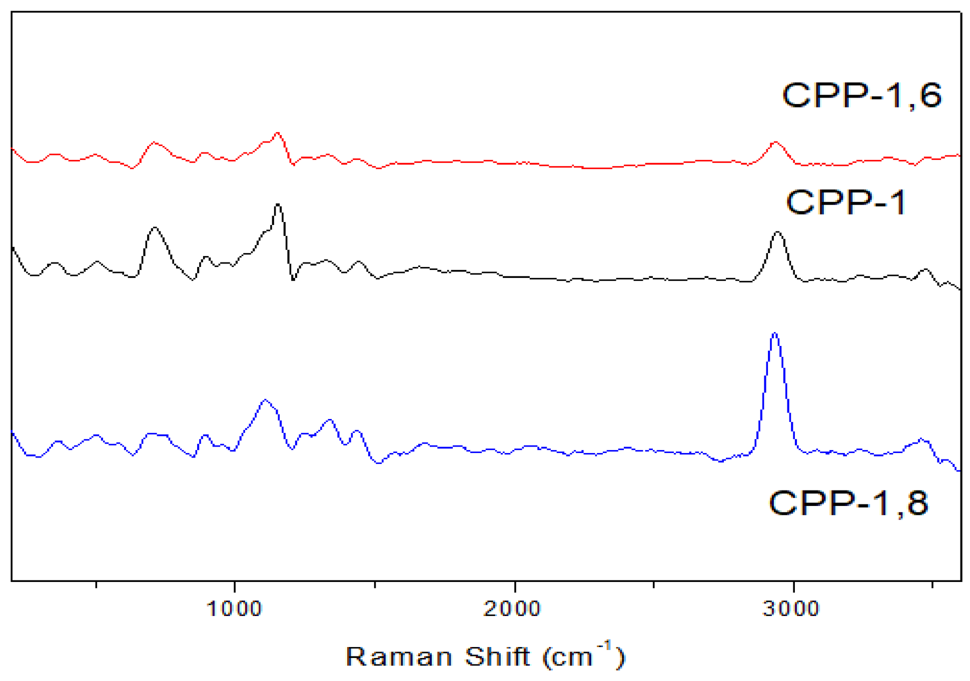

Figure 3. Raman spectrum of composite materials.

- **XRD**

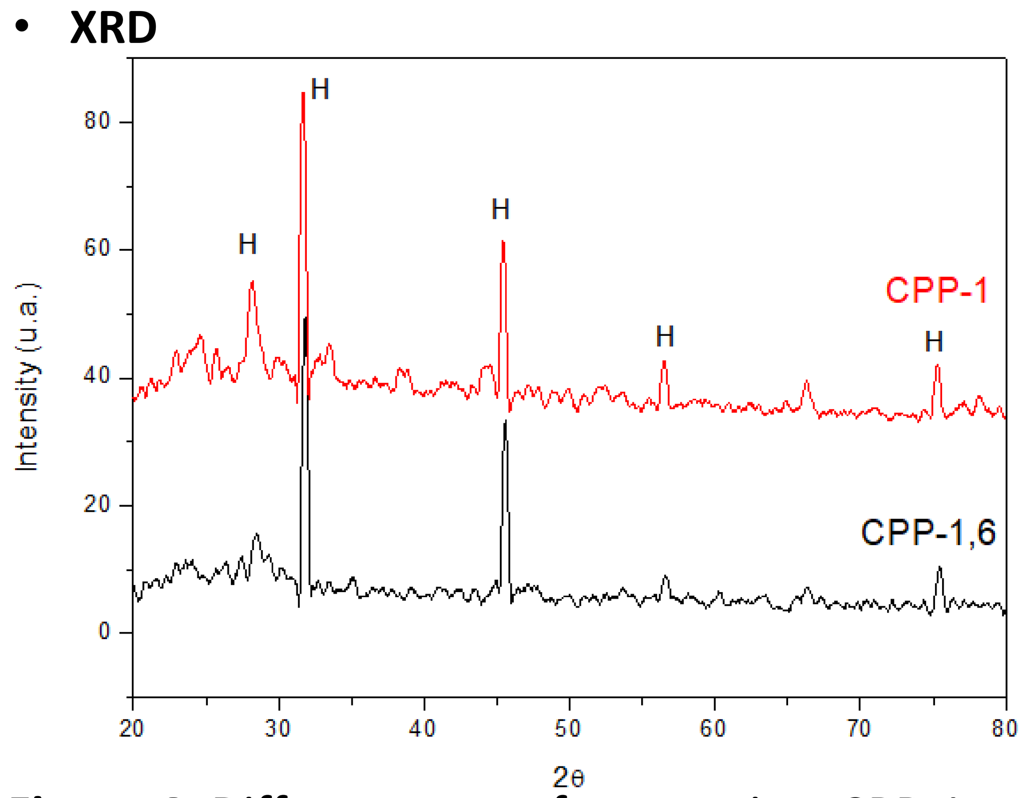

Figure 4. Diffractogram of composites CPP-1 and CPP-1.6

- **SEM**

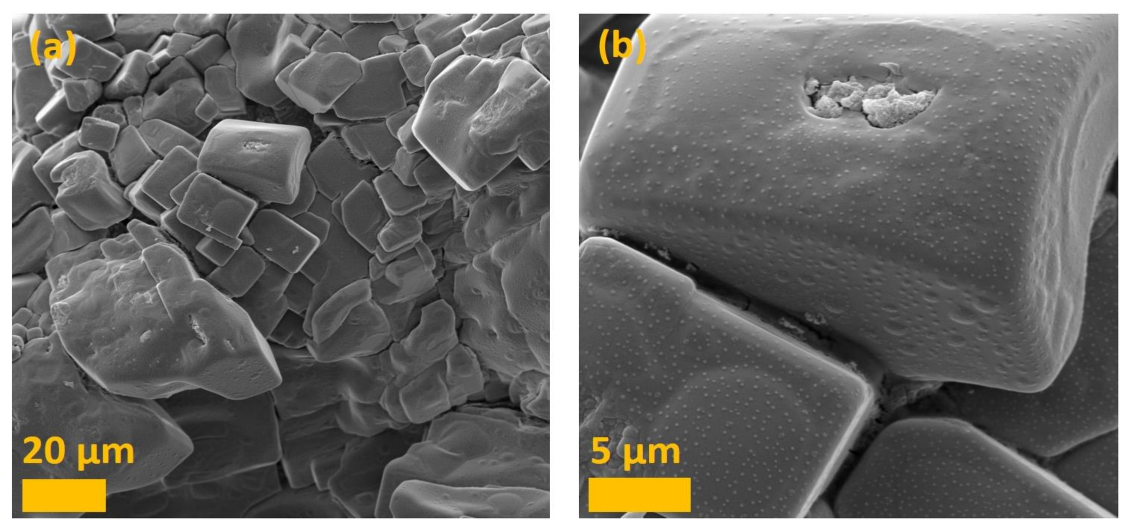

Figure 5. Micrographs of the CPP-1.6 sample.

- **EDS**

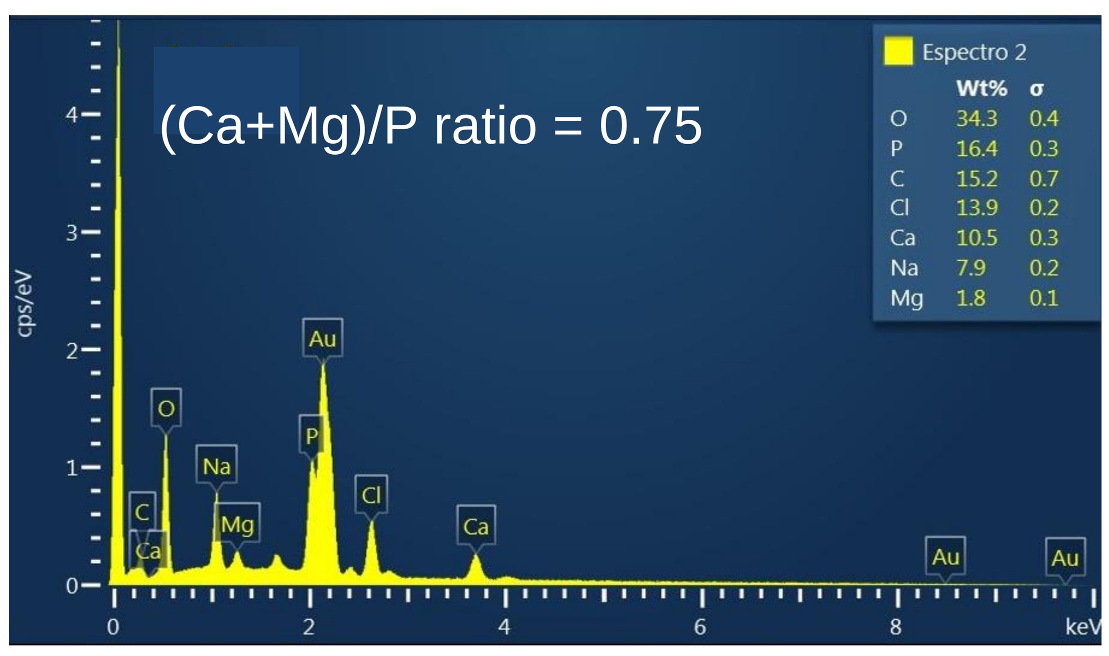

Figure 6. Elemental analysis obtained by EDS of the CPP-1.6 sample.

CONCLUSION

The composite materials were successfully obtained through the precipitation reaction. Through spectroscopic techniques, ATR-FTIR and Raman, CPP and alginate presence, while Mg incorporation was elucidated by EDS spectroscopy. The materials presented cubic morphology and crystalline phases referring to monetite and HAp. The results indicate the potential use of these composites as scaffolds for bone regeneration.

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