Inverted Colloidal Crystal Scaffolds for Bone Tissue Engineering

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1

Inverted colloidal crystals (ICC) are inverse replicas of an ordered array of monodisperse colloidal particles, organized in packed long-range crystals. In recent years, several groups have suggested the use of the ICC structure as a solution to obtain scaffolds with uniform and adjustable pore size, high interconnectivity and suitable mechanical properties. Thanks to its architecture, the results have confirmed this scaffold as capable of enhancing cell adhesion, migration and distribution and also an improved exchange of nutrients and metabolic wastes.

Giannoudis *et al.*, 2005

In this work we report the use of ICC technology to construct chitosan (CS), hydroxyapatite (HA) and composite CS/HA scaffolds for Bone Tissue Engineering. applications.

2

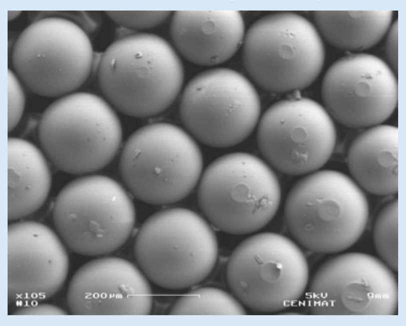
Polystyrene microspheres were produced with oil-in-water stable emulsions through the mixture of two phases.

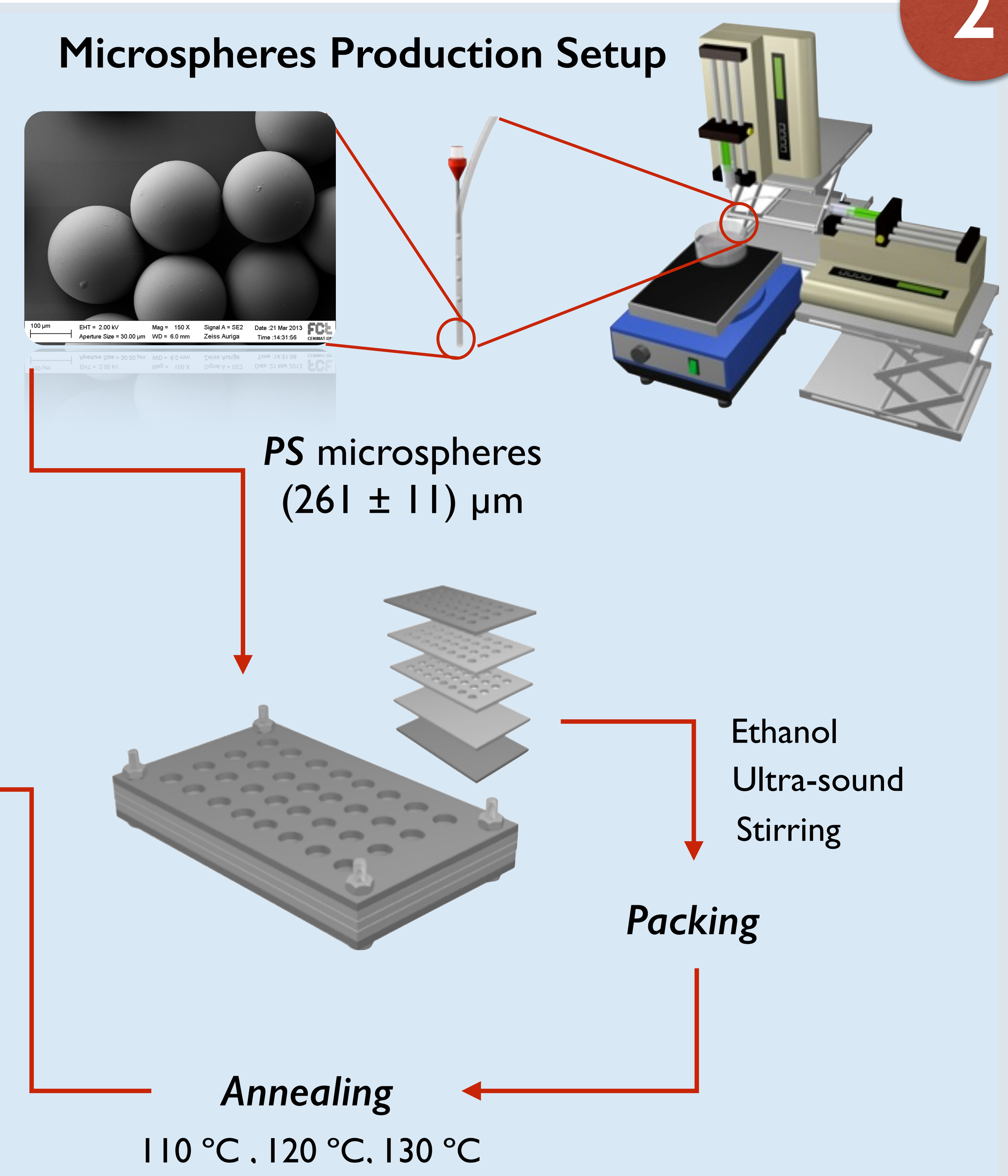
- Discontinuous phase - 5 wt% PS (Mn=350000, Aldrich) in methylene chloride (Fluka)
- Continuous phase - 5 wt% PVA (Mw=95000, Acros Organics) aqueous solution.

Microspheres Production Setup

ICC Scaffold Production

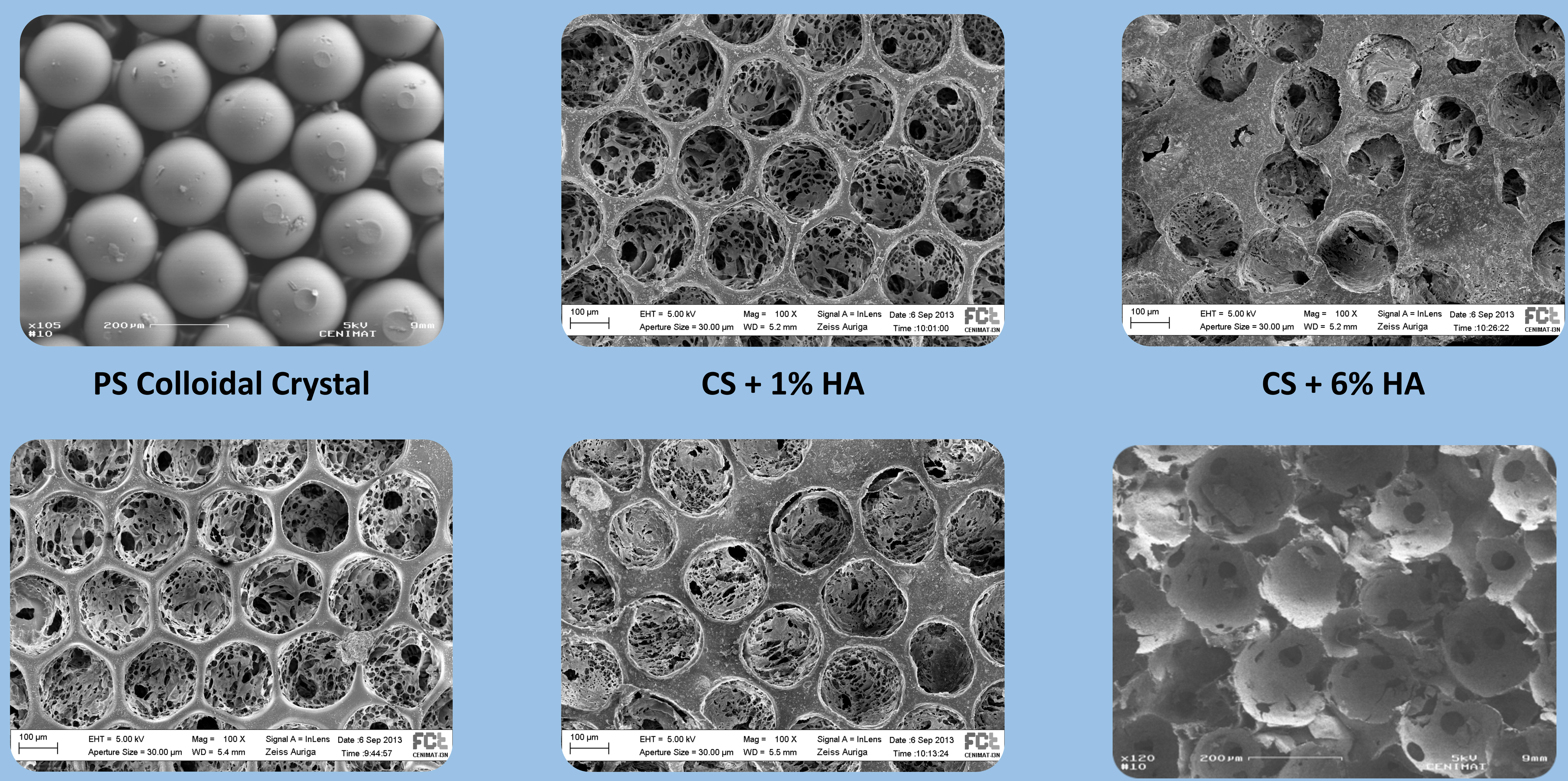
Colloidal Crystal (CC)





The CC is infiltrated with solutions of CS, HA or CS/HA. After, the spheres are removed by dissolution, giving rise to the ICC scaffold.

ICC Scaffolds



PS Colloidal Crystal | CS + 1% HA | CS + 6% HA

CS | CS + 3%HA | HA

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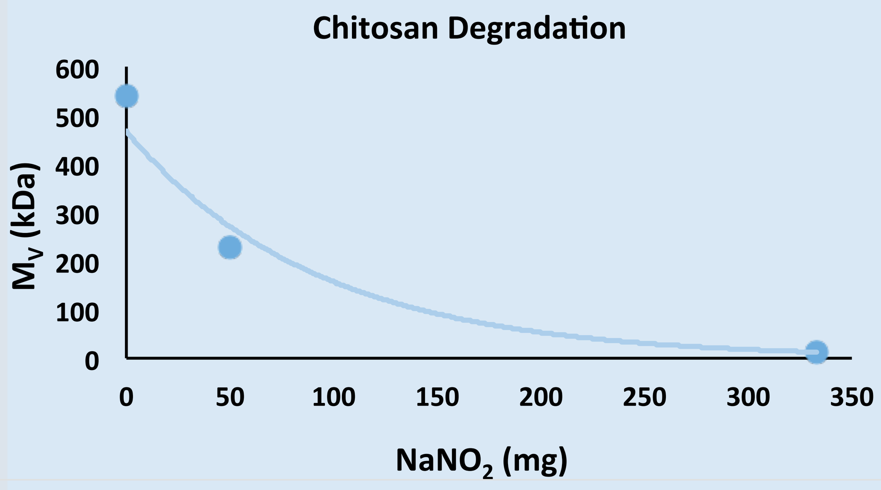
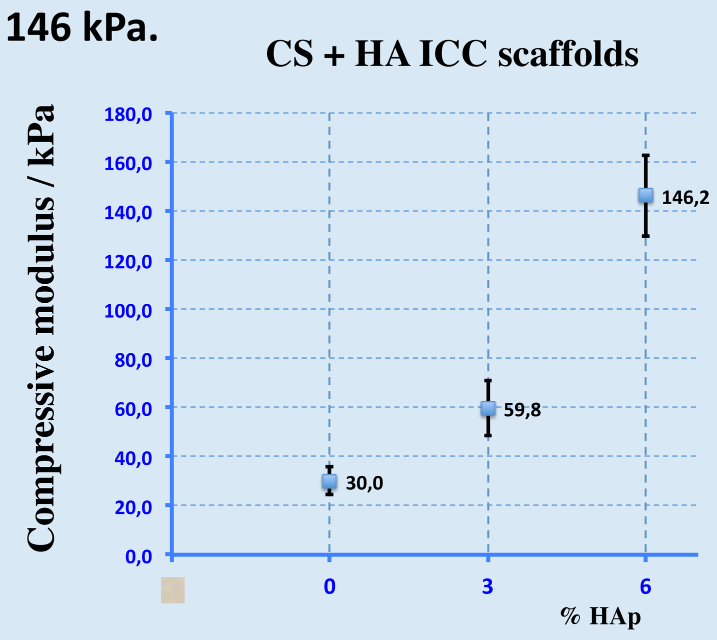
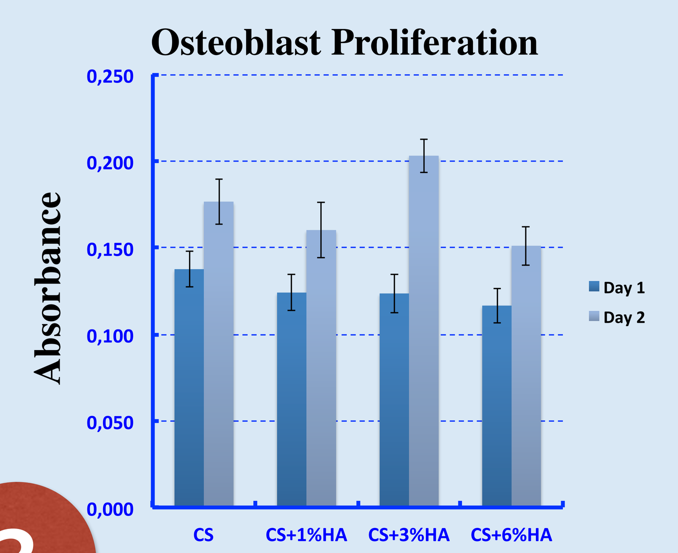


Three chitosans with different Molecular weight were used to produce the ICC scaffolds.

Compression tests revealed that composite chitosan-hydroxyapatite ICC scaffolds have enhanced mechanical properties with increasing HAp content. The compressive modulus varies from 30 to 146 kPa.



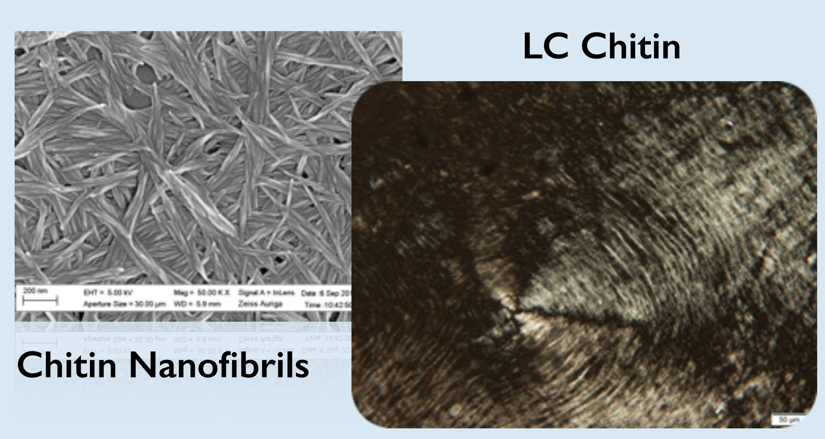


Cellular adhesion evaluation revealed good interaction between osteoblasts and the scaffolds. Proliferation profiles exhibit cell growth of 128 ±13%, 129 ± 17%, 164 ± 17% and 130 ± 15% for CS, CS+1%HA, CS+3%HA and CS+6%HA ICC scaffolds, respectively.

4

Highly porous composite CS/HA scaffolds, having 0%, 1%, 3% and 6% (wt/v) HA were produced using Inverse Colloidal Crystal technique. Also pure HA ICC scaffolds were successfully created by template infiltration with sol-gel mixture.

These ICC scaffolds have excellent pore interconnectivity and showed good mechanical properties and in vitro cell support, enhanced by electric polarization.



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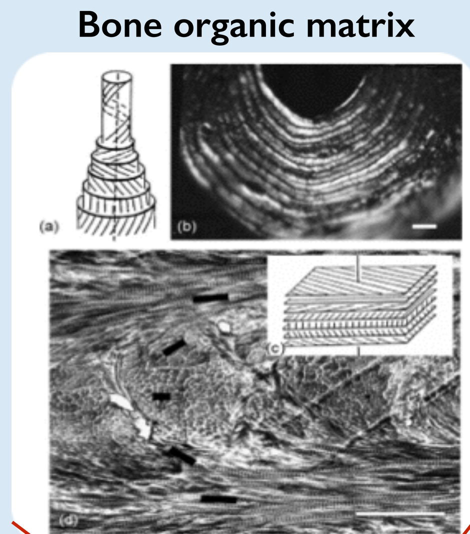
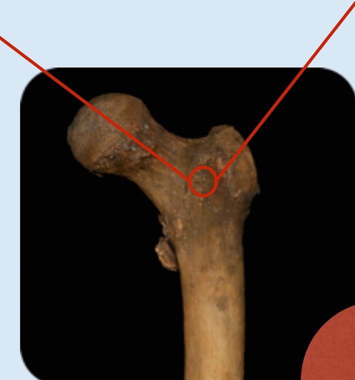
Bone organic matrix





Future work in this project will be focused on producing a scaffold matrix that mimics the organization and composition of human bone. This will be achieved with a combination of chitosan/chitin liquid crystalline (LC) mesophase matrix, similar to the organization of collagen fibrils in bone, and hydroxyapatite, similar to bone ceramic phase.

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