

## Glass and Bioactive Glass Nanopowders by Flame Synthesis

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**INTRODUCTION:** Glasses and glass ceramics consist of undercooled, partially or fully amorphous materials and are used since thousands of years for their intriguing properties. Certain glass compositions known as Bioglass® or bioactive glasses were found to form a tight bond with living bone [1]. These materials can be applied for bone repair and regeneration of defects arising from trauma, tumour and osteoporosis [2]. Solid state reactions and sol-gel processes can be limiting in terms of composition, high remaining solvent content and generally require an annealing or sintering step after preparation [3]. Here we would like to show the direct synthesis of bioglass nanoparticles in a high temperature environment and illustrate the advantages in terms of accessible composition, homogeneity and particle size.

**METHODS:** Precursors of all materials have been prepared by correspondingly mixing 2-ethylhexanoic acid salts of calcium and sodium with hexamethyldisiloxane tributyl phosphate and fluorobenzene. The liquid mixtures were fed through a capillary into a methane/oxygen flame. Oxygen was used to disperse the liquid leaving the capillary (Fig. 1).

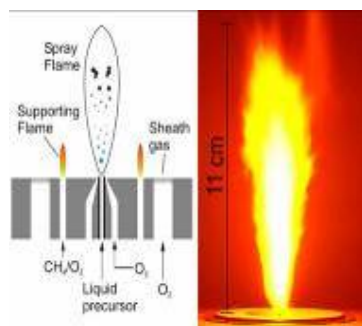


Fig. 1: (a) Sketch of the experimental set-up. (b) The burning spray of a calcium phosphate producing flame synthesis unit.

**RESULTS:** Flame spray synthesis was used to prepare 45S5, 45S5F and 77S-type of Bioglass. The as-prepared bioactive glasses consist of XRD-amorphous nanoparticles with a primary particle size of 20-80 nm ( $SSA_{BET}$  70-200 m<sup>2</sup>/g depending on composition).

After immersion of the 45S5 type of bioactive glass in simulated body fluid (SBF) for 7 days,

Raman spectroscopy and electron microscopy was used to assess the surface of the material. The formation of a crystalline carbonated apatite layer was observed thus confirming the bioactivity of the material (Fig. 2).

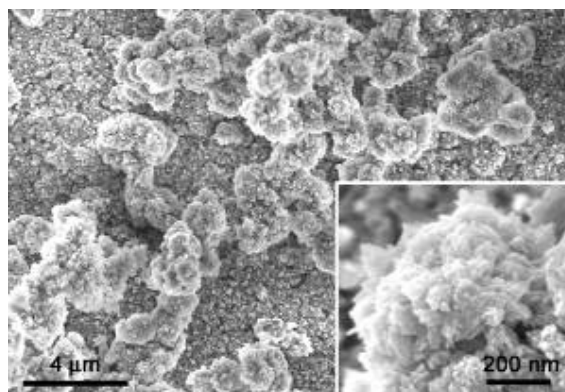


Fig. 2: SEM image of Bioglass 45S5 after incubation in SBF.

**DISCUSSION & CONCLUSIONS:** Complex glasses consisting of 5 elements could be readily produced as nanoparticles using a flame spray reactor. The high temperature synthesis allows the preparation of a well defined, homogenous and amorphous material. The material showed deposition of bone-like carbonated hydroxyapatite after immersion in SBF, which corroborates the bioactivity of the bioactive glass.

**REFERENCES:** [1] L.L. Hench (1971) *J. Biomed. Mat. Res.* **5**:117-41, [2] T. Nakamura, T. Yamamuro, S. Higashi et al. (1985) *J. Biomed. Mat. Res.* **19**:685-98, [3] R. Roy, *Science* (1987) **238**:1664-9

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