Kinetic study in situ dissolution of particles of 45S5 Bioglass® assisted by laser diffraction spectrometry (LDS).

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Keywords: *bioglass, dissolution kinetics, laser diffraction, particle size.*

Introduction

Particles of Bioglass® 45S5 have been widely used to fill bone defects. Its success has been attributed to the ability to form bond to tissues by a calcium phosphate layer, as well as the ability to enhance osteogenesis through a direct control over genes that regulate induction and progression cell cycle[1]

The mechanism to explain the bioactivity and reactivity of bioactive glasses, proposed by Hench and Clarck involves the ion exchange of sodium and calcium ions in the glass with hydrogen ions present in the body fluids and the formation of a silica-gel layer over the particles, which acts as nucleation centers for calcium phosphate[2].

Laser diffraction spectrometry based on Mie scattering is particularly useful technique to study particles dissolution, growing or aggregation.

The aim of this work is contribute to enhance the understanding of the behavior of the Bioglass® 45S5 particles size, due to its surface modifications in the early stages, when dispersed into water buffer solution at physiological pH 7.4.

Results e Discussions

Bioglass® 45S5 (45.0%SiO_2 · 24.5%Na_2O · 24.5 %CaO · 6.0%P_2O_5, wt%) was prepared by the conventional melt-quenching technique. The quenched glass was cutter in disc and ground in a ball mill previously to LDS analysis. Bioglass 45S5 particles were dispersed in HEPES ($5.0x10^{-2}$ mol·L^{-1}) water buffer solution at pH 7.4 and their size distribution was monitored in situ for 20 hrs under intense agitation.

Fig. 1 shows the behavior of particle size distribution during the agitation time.

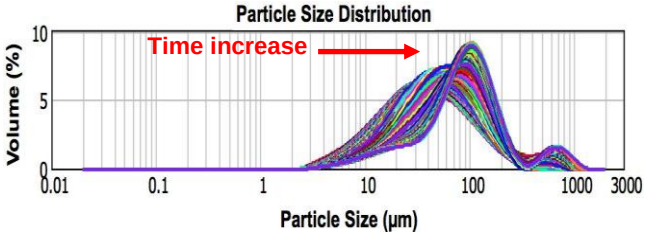

Figure 1 - In situ study of the distribution of particle size by LDS.

Figure 2 represents some curves extracted from Figure 1, showing for different dispersion times, the particles size distribution in water buffer under intense agitation.

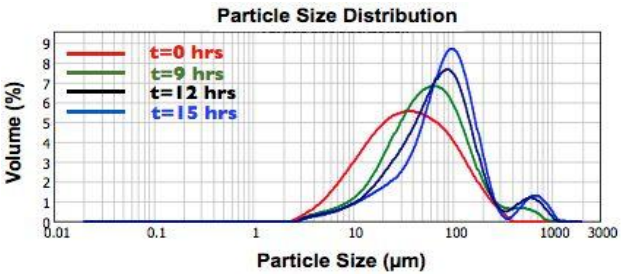

Figure 2. Particle size distribution curves selected from Fig.1.

The results shown in Figures 1 and Figure 2 indicate the growth of the bioglass particles during the whole studied period. After 9 hours of dispersion can be clearly also observed in the particle size distribution a increasing shoulder in large size values, that also shifts to large sizes with the increasing of the dispersion time.

This behavior suggests that the changes in the surfaces of particles of 45S5 (formation of a silica gel layer and may be the beginning of calcium phosphate crystallization) increase its size and may also be promoting the coalescence of them. The size increasing is also consequence of a mechanism like the Ostwald ripening, due to the solubility of Bioglass® 45S5.

Conclusion

This work was carried out in situ essays about the behavior of the 45S5 particles in aqueous solution buffered with HEPES. The results showed an increase in the size of the particles with time of dispersion due to the formation of the silica layer (and maybe calcium phosphate crystallization) on the particle surface and also the coalescence despite the intense agitation.

Acknowledgments

The authors thank to FAPESP for financial support.

[1]Hench, L. L., *J. European Ceram. Soc.* 2009, 29 (7), 1257-1265.
[2]Hench, L. L., *Am. Ceram. Soc. Bulletin* 1998, 77 (7), 67-74.