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New possible candidate for use as a basis for dental cement and biomaterial

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Abstract – New materials have been studied for several uses and applications, especially in dental and medical areas. In dentistry, a material based on a calcium-fluoroaluminosilicate matrix (CaFAlSi), with relative basicity, can be used as the basis for the glass ionomer dental cement. For applications in medicine, both CaFAlSi and glass ionomer cement can be applied as a biomaterial in situations that require a bone replacement. By the non-hydrolytic sol-gel method, a new material was synthesized showing different physical and chemical characteristics compared with the commercial CaFAlSi currently used. The material obtained by sol-gel methodology formed cements without superficial micro cracks and the biological tests demonstrated that the new materials are more biocompatible than the usual cements. Superficial cracks make the cement less durable and the new cement can be more stable to acid attack. For biological applications, the new material has lower irritative potential, assigning greater biocompatibility.

New materials have been studied for several uses and applications, especially in dental and medical areas. In dentistry, a material based on a calcium-fluoroaluminosilicate matrix (CaFAlSi), with relative basicity, can be used as the basis for the glass ionomer dental cement. The cement formation is based on a reaction between the CaFAlSi and an organic polyacid, usually polyacrylic acid. The CaFAlSi is attacked by protons from the acid, releasing Al^{3+} and Ca^{2+} to the medium. The cations are then complexed, forming carboxylate linkages between the acid molecules, promoting the cement formation [1]. The CaFAlSi and the glass ionomer cement can be applied as a bone substitute in specific clinical situations. By the non-hydrolytic sol-gel method, a new material was synthesized with different physical and chemical characteristics compared with CaFAlSi currently used [2]. By sol-gel route, the material (CaFAlSi A2) was prepared reacting $AlCl_3$, AlF_3, CaF_2, NaF, $AlPO_4$, $SiCl_4$, isopropyl ether and anhydrous ethanol, under inert atmosphere, at 110 °C and magnetic stirring for 4 hours. The obtained material was dried at 110 °C, resulting in a white fine powder. Ethanol and ether were the oxygen donors, promoting the formation of alkoxide groups. These groups are then condensed with chloride, forming the oxide linkage and releasing ethyl chloride as a sub product. The nominal composition was $7{,}00SiO_2$-$2{,}81Al_2O_3$-$0{,}16P_2O_5$-$2{,}01CaF_2$-$0{,}19AlF_3$-$2{,}21NaF$. The material was characterized by X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM) and biological tests. By XRD the CaFAlSi A2 presented predominantly amorphous structure (Fig. 1) and TEM analysis demonstrated particles with size from 1000 to 400 nm. The glass ionomer cement made using A2 showed milder inflammatory response and lower irritative response than the commercial glass ionomer cement, assigning greater biocompatibility, according to the biological tests. SEM of the A2 cement also showed no superficial cracks (Fig. 2a and 2b), which occurs on the commercial cements and compromises the mechanical and chemical resistance. In conclusion, the new material synthesized by sol-gel method presented singular characteristics, being possible to use as dental cement component and biomaterial, with better results than the CaFAlSi currently used.

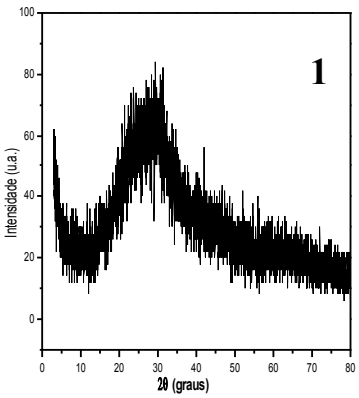

Figure 1: XRD of the CaFAlSi A2.

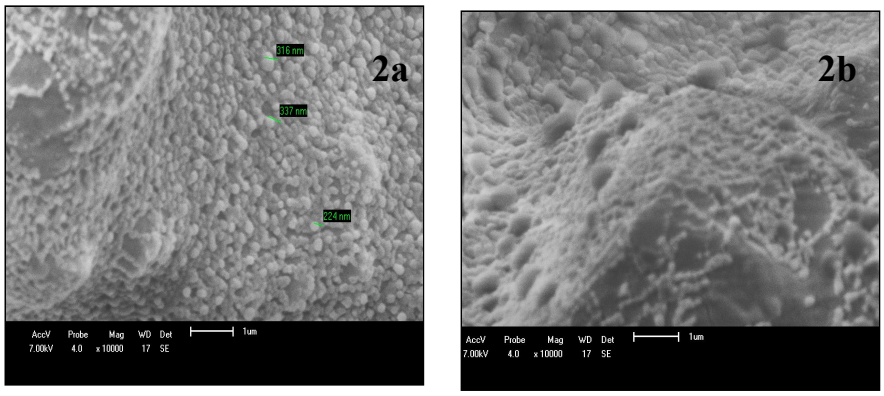

Figure 2: MEV image of the glass ionomer cement made with CaFAlSi A2.

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