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The Abstracts of the 28th International Biomedical Science and Technology Symposium

Editor

Nermin DEMİRKOL

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Production of Alumina (15 wt %) - Zirconia Based Dental Ceramics and Investigation of Bioactivity and Mechanical Properties

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Abstract

Dental ceramics are the materials of choice for oral restorations due to some of their properties such as adequate aesthetics, high fracture toughness and chemical stability. Nowadays, dental professionals can choose from a large number of ceramic systems with slight differences in terms of their chemistry, processing temperatures, mechanical strength and clinical applications[1]. In general terms, polycrystalline ceramics are non-metallic inorganic ceramic materials that do not contain a glass phase, providing higher strength and fracture toughness compared to glass ceramics. The main feature of the ceramics included in the polycrystalline group is the small grain crystal structure that gives strength and fracture toughness[2]. Alumina and zirconia are the most preferred materials in polycrystalline ceramics. Alumina has an important position in implant material technologies thanks to its high biocompatibility, superior hardness and high Young's modulus, while zirconia offers a preferred alternative in dentistry with its excellent mechanical properties and high fracture toughness. The combination of these two materials has great potential to both reinforce their individual strengths and overcome existing limitations.

This study focuses on the innovative development of dental composites based on alumina and zirconia. High purity alumina powder is used together with 3 mol% Y-TZP zirconia powder obtained by Nanografi Company. The composite was prepared in proportions of 15 wt.% alumina and 85 wt.% 3YSZ. In the preparation of the mixture, mixing was carried out for 4 hours at a mixing speed of 140 rpm using a zirconia ball. The prepared mixtures were separately pulverised and 10 mm diameter pellets were formed at 350 MPa pressing pressure in accordance with the British standard. The formed pellets were sintered at 1250 °C and 1350 °C at a sintering speed of 5°C/min for 2 hours. These samples were then used for density and microhardness measurements and *in vitro* bioactivity tests. Density measurements were made for samples sintered at 1250 °C and 1350 °C. Archimedes method was used for density calculations. The microhardness measurements of the samples sintered at different temperatures were measured by applying 200 g load for 15 seconds. The density and Vickers microhardness values of the composites increased in direct proportion to the increasing temperature. The highest density (4.94 g/cm^3) and the highest Vickers microhardness value (1004 HV) were obtained in the composite containing 15 wt% alumina sintered at 1350 °C. According to the density and hardness results of Alumina (15 wt.)-Zirconia composites, it was observed that they increased depending on the sintering temperature. The results are promising for dental applications. The higher density increases the durability of the material, while the improved hardness values support that it can provide longer lasting and reliable solutions in dental restorations. The composite samples containing 15 wt% alumina were used for bioactivity test. Samples were soaked in simulated body fluid (SBF) for 1 week, 2 weeks, 3 weeks and 4 weeks, seperately. The SBF liquid was replaced with freshly prepared liquid every two days to maintain the ion concentration at its original value. Increasing apatite formation was observed in the composite surface with increasing soaking time.

In conclusion, the obtained results showed that zirconia-based dental ceramic composite containing 15 wt% alumina have a promising potential.

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Keywords: Alumina, Zirconia, Bioceramic, Dental ceramics.

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