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Effect of magnesia and zirconia on the mechanical and biological properties of calcium silicate ceramics at C/S ratio of 0.5

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Recently, many research works have been done on the bio-ceramic materials based CaO-SiO₂ system. But, unfortunately the data presented in these works are not enough to complete understanding the relation between the formed phases and the final properties of the produced materials. It is highly important to understand the microstructure-properties relationship for developing new bioceramics. This work describes the effect of magnesia in the presence of zirconia on the bioactivity, microstructure and physico-mechanical properties of calcium silicate composition adjusted at calcia/silica ratio(C/S) of 0.5. A mixture from calcium carbonate and silica was conducted at C/S of 0.5. 20 wt.% of magnesia and 5-25 wt.% of ZrO₂ were added. Each mixture was mixed with ethanol in a planetary ball mill, dried, formed and fired at a temperature of 1325±5°C. Phase composition, FE-SEM, and physico-mechanical properties of the fired specimens were determined and explained. The *in vitro* bioactivities of these specimens were investigated by analysis of their abilities to form apatite in the simulated body fluid (SBF) for a short time (7 days) using SEM-EDS. The findings indicated that the surface of the specimens containing 5 and 15 wt.% ZrO₂ were completely covered by single and multilayered hydroxyapatite (HA) precipitate typical to “cauliflower” morphology, respectively. The surface of the specimen containing 25 wt.% ZrO₂ did not cover, but there are some scattered HA precipitate. The differences among the results were rationalized based on the phase composition. Vickers hardness and fracture toughness of the specimens of highly promised bioactivity were 2.32–2.57 GPa and 1.80–1.50 MPa. m^{1/2}, respectively. The properties of these specimens are similar to the properties of human cortical bone. Consequently, these composites might be used as bone implant materials.

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Mesoporous ZnFe₂O₄@TiO₂ nanofibers fabricated via electrospinning and PECVD for enhancement of photocatalytic properties

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The development of the dye industries was leading to increase in water contamination. This contamination supplies a serious threat to human. Therefore, many strategies have been developed to remove the organic dye from wastewater such as chemical flocculation, adsorption, and ion exchange. However, the traditional remediation of dye wastewater has many side effects, including the secondary pollution and long processing cycle. Recently, several investigations focused on the photocatalytic technology which is useful for degradation of organic dye into environmental friendly compounds (CO₂ and water) using semiconductor materials such as TiO₂. TiO₂ has attracted attention as a photocatalyst due to its relatively low cost, high stability and low toxicity. However, the high recombination rate between the electron-hole of TiO₂ limits the efficiency of the photocatalytic reaction. In addition, TiO₂ has a wide band gap (3.2 eV) and it can only be excited by UV light. In order to shift the absorption edge of TiO₂ to the visible range, ZnFe₂O₄@TiO₂ nanofibers were fabricated. These composite nanofibers were elaborated by combining the two techniques: Electrospinning and plasma enhanced chemical vapour deposition (PECVD). The nanofibers morphology and performance were optimized using different zinc/iron ratios. Their morphological, structural, and optical properties were analysed using scanning electron microscopy (SEM), X-ray diffraction (XRD), energy-dispersive X-ray spectroscopy (EDX), BET surface area, Raman spectroscopy and UV-Visible spectrophotometry. The photocatalytic activity has been investigated by degradation of methylene blue (MB) under visible light. The results indicated that the combination of spinel structure with titanium dioxide improved the photodegradation efficiency up to 98%. Deposition of TiO₂ via PECVD on zinc ferrite surfaces enhanced the absorption in the visible region and improved the electron-hole separation.

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