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Preparation and characterization of reduced graphene oxide/fluorhydroxyapatite composites for medical implants

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Abstract

Poor mechanical properties and a relatively low stability in physiological environments have significantly limited hydroxyapatite (HA) for many practical implant applications. In this study, we developed a reduced graphene oxide/fluorhydroxyapatite (rGO/FHA) biocomposite with enhanced mechanical properties, dissolution resistance, biocompatibility and antibacterial activity. rGO and fluorine (F) are simultaneously incorporated into HA to form the rGO/FHA composite by an *in situ* chemical synthesis method and spark plasma sintering technology. The uniform distribution of rGO and the good interfacial bonding help to improve the hardness by 86% and the fracture toughness by 137%. The chemical stability of the rGO/FHA composite is evaluated by determining the Ca^{2+} ion release. The result indicates that the substitution of F^- ions into the HA structure has a positive effect on the dissolution resistance of HA. The *in vitro* bioactivity assessment shows that the osteoblast adhesion and proliferation ability on the rGO/FHA composite are improved. In addition, a higher alkaline phosphate activity is also detected in cells cultured on the rGO/FHA composite. More importantly, it is observed that the rGO/FHA composite can effectively inhibit the adhesion and proliferation of *Streptococcus mutans*. These findings suggest that the rGO/FHA biocomposite would be highly useful as a dental implant material.

Keywords: Reduced graphene oxide, Fluorhydroxyapatite, *In situ* chemical synthesis, Spark plasma sintering, Implants

1. Introduction

Biomaterials based on calcium phosphate, especially hydroxyapatite (HA,