Chapter 14
Synthesis, Characterization, and Antimicrobial Activity of Sr-HAP Powders for Biomedical Applications

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ABSTRACT

An important objective is to develop a biomaterial that can be used as bone-substituted materials with bacterial protection. Calcium-Phosphate and substituted HAP-based ceramic materials are considered as one of the potential candidate for bone and bone-related clinical applications. These ceramics are adequately biocompatible and do not induce adverse local tissue reactions, immunogenicity, or systemic toxicity. Furthermore, since this material is osteoconductive, it acts as a support for new bone formation within the pore sites, which are deliberately generated in the structure. In the biomedicine field, nanoparticles can be used as drug-delivery vehicles that can target tissues or cells and can be functionalized with special characteristics for qualitative or quantitative detection of tumor cells. For these reasons, the scope of the present work is to synthesize Sr-HAP powders with control of size, high quality, purity, and chemical composition by a microwave irradiation method at 720 W by varying aging time as 12 h, 24 h, and 48 h with uniform morphologies.

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1. INTRODUCTION

1.1 Biomaterials

Biomaterials are used for making devices that can interact with biological systems to coexist for longer time with minimal failure (Bronzino, 2006). Biomaterials are widely used in repair, replacement and augmentation of diseased or damaged parts of the musculoskeletal system such as bones, joints and teeth. The fundamental requirement of a biomaterial is that, the material and the tissue environment of the body should coexist without showing any undesirable or inappropriate effect on each other. Biomedical materials must not damage the body and must provide the required strength, especially high fatigue strength and toughness, in joint replacement therapies and other applications. The essence of a biomaterial is an economic (cheap) implant with the mechanical, physical, and chemical properties that provide structural capability without deleterious effects on the body. Biomedical devices when placed inside the body are termed as, "implants" - when they are intended to remain there for a substantial period of time, and as "prosthesis" - when they are permanently fixed in the body for long-term application till the end of lifetime.

1.2. Classification of Biomaterials

When a synthetic material is placed within the human body, tissue reacts towards the implant in a variety of ways depending on the material type. The mechanism of tissue interaction (if any) depends on the tissue response to the implant surface. In general, there are three terms in which a biomaterial may be described in or classified into representing the tissues responses. These are bioinert, bioresorbable, and bioactive, which are well covered in range of excellent review papers.

1.2.1. Bioinert Biomaterials

The term bioinert refers to any material that once placed in the human body has minimal interaction with its surrounding tissue, examples of these are stainless steel, titanium, alumina, partially stabilised zirconia, and ultra high molecular weight polyethylene. Generally a fibrous capsule might form around bioinert implants hence its biofunctionality relies on tissue integration through the implant.

1.2.2. Bioactive Biomaterials

Bioactive refers to a material, which upon being placed within the human body interacts with the surrounding bone and in some cases, even soft tissue. This occurs through a time – dependent kinetic modification of the surface, triggered by their implantation within the living bone. An ion – exchange reaction between the bioactive implant and surrounding body fluids – results in the formation of a biologically active carbonate apatite (CHAp) layer on the implant that is chemically and crystallographically equivalent to the mineral phase in bone. Prime examples of these materials are synthetic hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$], glass ceramic A-W and bioglass®.