CHAPTER I

INTRODUCTION

Bone repair and regeneration of bone defects arising from trauma, tumor or diseases can be very complex and results in serious clinical problems in orthopedic surgery. To solve these problems, therapies are employed such as autograft, allograft, xenograft and artificial implants. However, each type of graft has advantages and disadvantages

Autograft is a popular procedure for reconstructive surgery because it is taken from the patient. However, the amount of transplant is usually limited in supply, the resulting pain, the nerve damage and possible infection can be problematic. Allografts and xenografts are used in current clinical practice. However, these grafts can have a possible risk of transmission of bacterial and viral disease. Legal, religious and cultural limitations are also existed.

Thus, artificial bone replacement materials made from metals, ceramics, polymers and composites are of a great importance to replace using bone grafts. Ceramic materials used as biomaterials for repair and reconstruction of damaged parts of the human skeleton must have a minimum set of properties such as biocompatibility, be bioactive, bioresorbable and also should have good mechanical properties.

Bioceramic material is of interest for use as a bone replacement material because of its biocompatibility properties. It can be classified into two large groups, including bioinert and bioactive materials. Bioinert ceramics have almost no influence on the surrounding living tissue and include materials such as alumina and zirconia. Bioactive ceramics, by contrast, are capable of bonding with living osseous tissue, several deriving from the calcium phosphate group and certain compositions of glasses and ceramic glasses exhibit such a reported previously [1].

Calcium phosphate based bioceramics, including hydroxyapatite ($Ca_{10}(PO_4)_2$ $(OH)_2$:HA), tricalcium phosphate ($Ca_3(PO_4)_2$: TCP) and their composite materials, are the most popular material that is used widely as bone replacement materials in the field of orthopedic, surgery and dentistry. It is used as a matrix for controlled drug release in medical applications because of its similarity in composition to the mineral phase of natural bone, excellent biocompatibility, and ability to promote cellular functions and performance, and conductivity properties. Many experimental studies have shown that calcium phosphate can be used as an excellent material for repairing bone defects such as dense calcium phosphate coating on the porous substrates and calcium phosphate based composites. The pore structure of calcium phosphate implants is also regarded as a significant factor in promoting osteoinduction with the intention that the implanted porous ceramic will be progressively replaced by natural bone due to porous structure thus allowing cell attachment, proliferation, and provision of pathways for biofluids [2]. Therefore, the most important properties for use of Ca-P as a bone implant material are dependent on the high porosity and the interconnective pore structure due to its great influence on the final behavior of the implant. Porous biomaterials have been produced by several techniques such as using polymeric sponge, foaming processes and organic additives techniques [3,4,5]. Among various preparation methods, the polymeric sponge method is the most common technique for fabricating porous ceramics having high porosity, highly interconnected pores, uniform pore size distribution and controllable porous structure in the ceramics. However, it is well known that the mechanical strength of a material generally decreases as its porosity increase but high porosity in contrast improves the biological properties of materials. Consequently, several researchers have attempted to solve these problems by coating Ca-P compounds on ceramics or metallic materials such as porous Al_2O_3, ZrO_2, metal alloys, etc. Even though these materials have shown excellent mechanical properties but they are bioinert. However, bioactivity of HA is one of the most advantageous properties that would decrease with increasing amount of additive materials [6,7,8]. It has been reported that some type of glass ceramics and silicon additions can promote the rapid rate of surface reaction which leads to faster tissue bonding. Some types of glass ceramic may improve mechanical strength of the artificial implants [7,8,9]. From this point of view, if the advantages of porous Ca-P ceramics using glass in fabrication by employing the polymeric sponge method, then the glass can promote the bioactive property of HA. It could then perhaps be used as an excellent bone substitute. Silicon oxide and silicon oxide reinforced calcium phosphate porous bodies should have bioactivity, a sufficient biodegradation rate and mechanical stability, and should be replaceable by bone cell i*n vitro*.

The objectives of this study were to fabricate porous hydroxyapatite and to improve its mechanical strength and biological properties. Silicon oxide and silicon oxide in form of melted glass having a low melting point were used as additives, combined with the polymeric sponge method that is suitable for commercialization in term of simplicity, low cost. Detailed objectives are described as follows;

1. To fabricate porous hydroxyapatite with silicon oxide and glass frit (frit no.7406) additives by uniaxial pressing method.

2. To study the effected of silicon oxide and glass frit additive parameters such as concentration, sintering temperature etc, on phase formation, microstructure evolution, mechanical strength and biological property. These results will be used to provide fundamental data for the next step, preparation of porous HA by the polymeric sponge method which produces the same structure as porous bone.

3. To fabricate porous hydroxyapatite with glass frit additive by the polymeric sponge method.

4. To study the effect of porous HA with glass frit additive on mechanical properties, and compare with pure HA.