Available online at www.sciencedirect.com

ScienceDirect

Procedia Chemistry 19 (2016) 566 – 570

Procedia Chemistry

5th International Conference on Recent Advances in Materials, Minerals and Environment (RAMM) & 2nd International Postgraduate Conference on Materials, Mineral and Polymer (MAMIP), 4-6 August 2015

# Bioactivity of a Bio-composite Fabricated from CoCrMo/Bioactive Glass by Powder Metallurgy Method for Biomedical Application

Rohaya Abdullah[a], Nur Maizatul Shima Adzali[b], Zuraidawani Che Daud[c]

[a]Sustainable Engineering Cluster, School of Materials Engineering, Universiti Malaysia Perlis, 01000 Kangar Perlis, Malaysia
[b]School of Materials Engineering, Universiti Malaysia Perlis, 01000 Jejawi Perlis, Malaysia
[c]School of Materials Engineering, Universiti Malaysia Perlis, 0100 Jejawi Perlis, Malaysia

**Abstract**

In present times, researchers are attracted towards studies on biocomposite as a potential biodegradable bone implant materials. Bioactivity of the composite in a simulated body fluid (SBF) was investigated. A porous Co-Cr-Mo based composite material with bio-glass 45S5 was produce by using powder metallurgy method (PM) technology. Prepared composite powders were cold pressed and sintered at 1000°C for 2 h. X-ray diffraction (XRD), scanning electron microscopy were used for phase analysis and also for evaluation of particle distribution of composites. Bioactivity behaviour of the prepared nanocomposites was evaluated in simulated body fluid (SBF) for 1 up to 18 days. The results showed that the apatite layer were formed on the surface of sample with addition of bioactive glass. It was concluded that bioinert Co-Cr-Mo alloy could be successfully converted into bioactive composite by adding 6 wt% of BG particles.



Peer-review under responsibility of School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia

*Keywords:* CoCrMo alloy; Bioactivity; Composite; Bioglass

## 1. Introduction

The development of biomaterials field is originated from thousands of years back. Researchers have found that the corpses implanted with metallic dental implants which ages as old as 200 A.D. They have been found in the old civilization finding such as Romans, Aztecs, and Chinese[8]. Major metals used in medical applications today include: commercially pure titanium and its alloys (largely the Ti–6Al–4V and Ti–Al–Nb, and several _-Ti alloys). cobalt-based alloys (primarily Co–Cr–Mo line), stainless steel(mainly type 316L) Katti, 2004; Kohn, 1998;Long and Rack, 1998) [2].

However, titanium alloys are seldom used in tribological contact situation, mainly because of their poor wear resistance[1]. The austenitic steel 316L is recommended rather for short-term implants and elements of osteosynthesis,


Peer-review under responsibility of School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia
doi:10.1016/j.proche.2016.03.054

such as nails, screws, plates, with regard to worse corrosion resistance as well as the danger of allergic reaction appearance in a big number of patients [3].

Presently among the metallic materials used for orthopaedic implants cobalt-based alloys occupy a better application. It is estimated that about 50% of the artificial hip prosthesis are made of CoCrMo alloys (Huang and Lopez, 1999). These alloys are commonly used as implants due to their good biotolerance and the corrosion resistance.

Metallic implants are bioinert and present poor interfacial bond between the tissue and the implant due to bioinert surface. Surface treatment, compositional improvement, structural modification or changing the bioinert property into bioactivity could increase the interfacial bond between living cells and implant materials in order to increase the *in vivo* lifetime. Therefore, a good combination of the bioactivity and mechanical properties of metals are considered as an approach to fabricating better biomedical applications.

In recent years, the essential requirement for an artificial requirement to exhibit a bone bonding to living bone is the formation of a bone-like apatite layer on its surface in body environment. From previous studies it proven that a simulated body fluid (SBF), which has almost same ion concentrations as human plasma and was first used by[5] can well reproduce the in-vivo surface changes in certain biomaterials. In this present work, a biocomposite was fabricated by powder metallurgy method to investigate the bioactivity of the composite in the above-simulated body fluid. This work will contribute in osseous surgery which concerning on bio-tolerance and mechanical properties. This is because the available research only focusing on mechanical properties.

## 2. Experimental Procedure

### *2.1. Immersion in the simulated body fluid*

The simulated body fluid (SBF) was prepared by dissolving chemical reagent chemicals of NaCl, $NaHCO_3$, KCl, $K_2HPO_4 \cdot 3H_2O$, $MgCl_2 \cdot 6H_2O$, $CaCl_2$, and $Na_2SO_4$ in deionized water. The fluid was then buffered at physiological pH 7.4 and at 37°C with $((HOCH_2)_3CNH_2)$ and HCl. The ion concentration is shown in Table 1.

Table 1. Ion concentration of the simulated body fluid (SBF) and human blood plasma (mM)

| | Ion concentrations (mM) | |
|---|---|---|
| | Blood plasma | SBF |
| $Na^+$ | 142.0 | 142.0 |
| $K^+$ | 5.0 | 5.0 |
| $Mg^{2+}$ | 1.5 | 1.5 |
| $Ca^{2+}$ | 2.5 | 2.5 |
| $Cl^-$ | 103.0 | 147.8 |
| $HCO_3$ | 27.0 | 4.2 |
| $HPO^{2-}_4$ | 1.0 | 1.0 |
| $SO_4$ | 0.5 | 0.5 |

Before being soaked into the SBF, surfaces of the specimen was polished with 400, 600, 800, 1000 and 1200 grit papers. Then they were dried with a hair-dryer. The samples were subsequently immersed into the SBF for 18 days. The immersion tests were carried out in a shaking bath maintained at 37°C.