Dimensional Accuracy Study of Open Cellular Structure CoCrMo Alloy Fabricated by Selective Laser Melting Process

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Abstract. Designing orthodontic implants with desired physical and biological performances and to fabricate net shape with complex anatomical shapes is still a challenge. Cautious design approaches followed by systematic manufactural techniques that can achieve balanced physical performance in mono block implants mechanics is necessary to accomplish this objective. Metal additive manufacturing (MAM) technique such as selective laser melting (SLM) process is progressively being utilized for new biomaterials such as cobalt-chrome-molybdenum (CoCrMo). This study was designed to determine a dimensional accuracy of open cellular structures CoCrMo samples with designed volume based porosity ranging between 0% (full dense) to 80%. A maximum 2.10% shrinkage was obtained by 80% designed porosity sample. Samples with higher volume-to-surface area (full dense) demonstrated low total amount of shrinkage as compared to lower volume-to-surface area (80% designed porosity).

INTRODUCTION

Dental implants manufactured from biomedical alloys such as cobalt chrome based alloy have commonly been used for management of tooth loss in a human jawbone. Previous researcher, Yolanda et al. [1] investigated the influence of the laser melting process on corrosion and metal release for CoCrMo dental alloys fabricated by SLM. The rapid cooling rate and fine cellular microstructure offered by SLM sample of higher corrosion resistance compared with a cast CoCrMo alloy. This study was designed to determine a dimensional accuracy of open cellular structures CoCrMo samples with designed volume based porosity ranging between 0% (full dense) to 80%. A maximum 2.10% shrinkage was obtained by 80% designed porosity sample. Samples with higher volume-to-surface area (full dense) demonstrated low total amount of shrinkage as compared to lower volume-to-surface area (80% designed porosity).

Dental implants are inert, alloplastic materials embedded in maxilla and mandible sections to aid replacement of lost orofacial structures as a result of trauma, neoplasia and congenital defects [2]. The most common type of dental implant is endosseous comprising a discrete, single implant unit placed within a drilled space in dentoalveolar or basal bone [2]. Post operatively, the load transfer into host bones can be reduced by the insertion of stiff fully dense metallic implants that exhibit homogeneous and isotropic behaviour [3]. Stress shielding is a phenomenon refers to reduction in bone density (osteopenia) as a result of removal of normal stress from the bone by the implant. According to Wolff's law, bone in a healthy person or animal will remodel in response to the loads it is placed under. Therefore, if the loading on a bone decreases, the bone will become less dense and weaker because there is no stimulus for continued remodeling that is required to maintain bone mass. The stress shielding promotes premature implant loosening and escalates the need for revision surgery through a loss in periprosthetic bone density [4]. Thus, porous structured especially metallic implant which represents reduced density structure is increasingly exploited in minimizing the effect.