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Effect of Environmental Exposure on Two Types of Opaque Dental Porcelain

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Abstract

The objective of this study is to determine the effect of simulated body fluid (SBF) exposure on two types of opaque dental porcelain, i.e., local opaque dental porcelain and commercial opaque dental porcelain before it can be applied for the dental applications. The first type has been produced at the School of Materials and Mineral Resources Engineering. Two tests were applied to determine the environmental properties. These tests include; compression test and absorption of SBF. For compression test performed after immersed in simulated body fluid, very little changes in strength can be observed for both porcelains. The absorption of simulated body fluid test shows that no change in the weight and no obvious changes when observed under SEM after immersed in SBF at 37°C for certain time. The two types of opaque dental porcelain are nearly at the same range.

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Keywords: Simulated body fluid (SBF); Local opaque dental porcelain; Commercial opaque dental porcelain; Dental applications.

1. Introduction

Porcelain has been used for denture teeth since 1790 [1]. It is a specific type of ceramic is essentially made from clay, quartz and feldspar. The ingredients are pulverised, mixed, formed into shape and fire [2]. The materials used for dental application place a very high demand upon the chemical, physical, mechanical, optical and biological

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characteristics, they must be capable of responding successfully to the stresses and strains which induced during function and must also be capable of withstanding the corrosive environment of the mouth. Porcelain has the advantage over other materials in that they are usually harder and has a great resistance to abrasion [3]. Aesthetically, porcelain is an almost perfect material for the replacement of missing tooth substance. It is available in a range of shades and at various levels of translucency such that a most life-like appearance can be achieved. The inner layer of the porcelain crown is normally constructed from a fairly opaque 'core' material. This overlaid with a more translucent 'dentine' material with a final coating of translucent 'enamel' porcelain forming the outermost layer [4]. Porcelain often has superb biocompatibility, which is of importance in their use dentally [5]. The in vitro cellular responses to several types of dental ceramics currently in use are not equivalent and are not always favourable. Aging of the materials in biologic environments may produce marked improvements in cellular responses, although these improvements may be negated in some materials if the surface layers are disturbed sufficiently. Most of the ceramic materials did not carry high biologic risks [6]. One of the requirements for a dental restorative material is that it must be stable in the oral environment. In other words, it should undergo a minimal amount of dimensional change and chemical alteration [7].

2. Materials and methods

The composition of the local opaque dental porcelain was based on the work by Ibsen [8]. From this chemical composition, raw materials as given in Table 1 were selected. The raw materials used in this study were supplied by R & M Chemicals (UK) Limited except K-feldspar and Na-feldspar, which are bought from a local supplier. Each powder of the raw materials was weighted using 4 decimal points balance (Precisa, Model XT220A). The composition was dry mixed using a plastic container with 10 zirconia balls. The mixing was carried out for 2 hours using a mixer (Multi-Drive). The mixed powder was transferred into an alumina crucible before subjected to the melting process at 1350 °C for 4 hours using Lenton glass melting furnace. The molten product took out from the furnace and immediately quenched in cold water to form frit. The frit was dried before crushed using a fast mill machine to produce below 75 μm powders. This is the base-opaque dental porcelain powder. The powder was pressed at 60 MPa to form 13 mm diameter pellets. Each pellet was sintered using dental furnace for three minutes. The soaking time at the maximum temperature 980 °C is 1 minute according to the instructions of the manufacturer (Vision).

Table 1. Raw materials for preparation of opaque dental porcelain base frit.

Ingredient	Weight %
$Na_2O_3.Al_2O_3.6SiO_2$	27.91
$K_2O.Al_2O_3.6SiO_2$	51.46
$Al_2O_3.2SiO_2.2H_2O$	0.70
SiO_2	11.00
Al_2O_3	1.06
Na_2CO_3	1.38
KC_2O_3	2.95
$MgCO_3$	0.28
$CaCO_3$	1.29
$SrCO_3$	0.08
$BaCO_3$	0.28
TiO_2	0.115
Li_2CO_3	1.50