CHAPTER 1
INTRODUCTION

1.1 Overview

Porcelain-based ceramics have been widely investigated for the use of restorative materials in dental applications because of their esthetics, low thermal conductivity and excellent biocompatibility. However, similar to other glass-ceramics, a major impediment to dentistry of porcelains is their brittleness, which often restricts their utilization in fields where high strength and toughness are required [1-3]. Some attempts have been made to solve these issues by reinforcing the glassy matrix with some high strength phases such as alumina (Al_2O_3), zirconia (ZrO_2) or leucite ($KAlSi_2O_6$) [2-5]. A significant milestone in this respect was established in the development of dental ceramics containing leucite crystalline phase because their excellent thermal compatibility when bonding to metals and also a reinforcing agent in all ceramic restorations [6-9]. It has been reported that leucite glass-ceramics can be fabricated by controlled crystallization of a glass via leucite additive, heat treatment and etc. [10-12]. In general, commercial dental porcelain ceramics contain some amount of leucite crystals sized ~5-10 μm causing extensive microcracking around these non-uniformed leucite crystals [12]. To overcome these problems, several efforts have been made to tailor the leucite morphology, volume fraction and distribution which is thought to affect the mechanical properties of these porcelain ceramics via heat treatment [10, 11] or heat pressing [7].

In recent years, there is a great deal of interest in the fabrication and characterization of ceramic-nanocomposites due to their excellent mechanical properties [2, 3]. In connection with this, an effective method called “two-step sintering” has been proposed by Chen & Wang [13] for the preparation of Y_2O_3 ceramics with nano-sized grains. In this method, the first step is conducted by firing materials with constant heating rate in order to achieve an initial high density, and then a second firing step is held at a lower temperature (i.e. tempering) by isothermal sintering aiming to increase the density without obvious grain growth. So far there is

only work of Cattell et al. [11] who successfully produced porcelain-based ceramics with uniform distribution of fine leucite crystals in glassy matrix by tailoring the tempering time via the two-step sintering method. However they could not reach the nanocomposites structure. Although the study on the formation of leucite crystalline in porcelains has been reported by several researchers [8, 10-12], attentions paid on ZrO_2-modified porcelain-based ceramics are very few. Moreover, to our knowledge a detail study considering the potential of two-step sintering for the production of nanocomposites in dental porcelain ceramics has not yet been widely reported.

1.2 Research Objectives

1.2.1 Explore the potential of the two-step sintering technique in the fabrication of 20 wt% ZrO_2-modified porcelain ceramic-nanocomposites.

1.2.2 Explore the effects of heat treatment on phase formation, densification, microstructure and mechanical properties in these porcelain ceramics.