UNIVERSITI TEKNOLOGI MARA

SYNTHESIZED ZIRCONIA POWDER FROM AUSTRALIAN ZIRCON SAND

MIMI FAZZLINDA BINTI MOHSIN

Thesis submitted in fulfilment

of the requirements for

Bachelor of Engineering (Hons) Chemical

Faculty of Chemical Engineering

January 2019

ABSTRACT

Zirconia (ZrO_2) is one of the bioceramic materials widely used in dental restorations in surgical applications. The Zirconia powder is synthesized using Australian zircon sand using the alkali fusion method at 500°C, 600°C, 700°C and 800°C of calcination temperature. The synthesized Zirconia are being analysed using X-Ray Diffractometer (XRD), particle size distribution, Scanning Electron Microscopy (SEM) and Brunauer–Emmett–Teller (BET). The results showed that synthesized zirconia are monoclinic phases and the surface area of the synthesized zirconia based on the calcination temperature for 500°C, 600°C, 700°C and 800°C are 0.0635 m^2/g, 0.135 m^2/g, 0.0268 m^2/g and 0.0288 m^2/g. For BET surface area are 1.0721 m^2/g, 0.6811 m^2/g, 1.8915 m^2/g and 1.5074 m^2/g. Based on SEM images, the surface structure of the powder has been determined and at zirconia that been calcined at 600°C showed the similarity with commercial zirconia. Due to the structure of zirconia are not stabilized, dopant zirconia with yttrium oxide (Y_2O_3) is done using ball milling to produce 3 mole % yttria stabilized zirconia (YSZ). The several tetragonal structure is determined in 3 mole % YSZ. The similarities of synthesized zirconia and commercial zirconia showed that the synthesized of zirconia powder from zircon sand is successful.

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent and the Most Merciful

Alhamdulillah, all praises go to the almighty Allah for his blessings in completing this thesis. I would like to express my gratitude to the Faculty of Chemical Engineering, UiTM Shah Alam for giving me the opportunity to be a student here. Special appreciation goes to my supervisor, Dr Istikamah Subuki for his supervision throughout this research. Her support and guidance has supported me to complete the experimental and thesis work. I would also like to extend my appreciation to the Zircon Mineral Malaysia for providing Australian Zircon Sand to me as raw material for this project. Special recognition is also given to Mrs. Fazira from SIRIM for allowing me to do samples analysis at their research centre during my experimental works.

To the all staff at level 5 and level 6 laboratories of Faculty Chemical Engineering, UiTM Shah Alam for their assistance in the laboratory and Mr. Abul from XRD laboratory at Faculty of Applied Science, UiTM Shah Alam for allowing me to do analysis there. Not forgotten, my sincere appreciation goes to my colleagues for their kindness and support throughout my time as undergraduate student. May Allah reward the blessing for all of them.

Last but not least, my deepest thankfulness is due to my parents who have given me so much until these days of my life. Also, my appreciation goes to my family for their moral support, love and prayers. To those who had indirectly contributed in this research, thank you.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Zirconia (ZrO_2) powder is white crystalline known as zirconium oxide. This powder is chemically inert and withstand with high temperatures, corrosion and thermal shock (Sommers et al., 2010). There several conditions of the zirconia which are in natural form or process form. Zirconium oxide is the condition when the zirconia is in the natural form and is known as mineral baddeleyite. In the process form, the zirconia is being processed by a thermal treatment called calcination to produce zirconia oxide with high temperature. Many researchers interested to do a study about zirconia powder because it is widely used in ceramic materials and used in many applications such as in the hard ceramics production in dentistry, application in scaffold bone tissue engineering and enamels. Melting point of zirconia is high which 2715°C and the boiling point is 4300°C make the toughest of zirconia is very high. Zirconia have unique properties because it's complex and temperature-dependent phase transitions. Pure zirconia exists 3 crystal phase, monoclinic, cubic and tetragonal depends on the temperature. The material can have sharp edges and very smooth surface when the powder in fine grain size. However, the weakness of the zirconia is shown during phase change in its physical characteristics when heated (Daou, 2014). The addition of stabilizer can overcome this problem. Yttria partially stabilized zirconia when the trial or yttrium oxide is added as stabilizer is one of the problems that have been solved (Hjerppe, 2015).

Yttria stabilized zirconia (YSZ) is a zirconium oxide in crystal structure with addition of yttrium oxide as stabilizer at room temperature and produce ceramic. (Abd El-Ghany & Sherief, 2016).YSZ is strongest ceramic because it is purely tetragonal phase and have highest strength between zirconia-based materials. (De Aza, Chevalier, Fantozzi, Schehl, & Torrecillas, 2003). Then, growth is hinder, and the fracture toughness is developed when crack is put into compression. This process considerably prolongs the lifetime and consistency of product made with stabilized zirconia. (Abd El-Ghany & Sherief, 2016). It also high in chemical and erosion resistant. Besides, in biomedical used especially orthopedics and dentistry are preferring to use YSZ because it excellent stability