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LATTICE EXPANSION AND CRYSTALLITE SIZE ANALYSES OF 50NiO-50BaC$_{0.54}$Z$_{0.36}$Y$_{0.1}$O$_{3-\delta}$ ANODE COMPOSITE FOR PROTON CERAMIC FUEL CELLS APPLICATION

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ABSTRACT

This study reports on the structured analyses of 50NiO-50BCZY anode composite materials that is an essential element in proton ceramic fuel cells (PCFCs) application. Knowledge about the best materials used for anode composite is needed in order to enhance the performance of the PCFCs. Hence, study on anode lattice expansion is critical to ensure that each component has close thermal expansion coefficients under the desired working conditions. Recent study has discovered some problems occurs such as fracture formation caused by thermal mismatch between anode layers. Besides that, in order to understand the properties of anode composite materials, crystallite size must be determined appropriately. In this work, product of sintered NiO-BCZY anode composite is developed to understand the properties of the anode materials. Two objectives were carried out which is to investigate the lattice expansion 50NiO:50BCZY anode composite by using High Temperature XRD (HT-XRD) at operating temperature from room temperature until 700 °C, and to calculate the crystallite size for 50NiO:50BCZY anode composite by using Scherrer's and Williamson Hall's methods. The results obtained revealed that the diffraction peaks of NiO and BCZY were matched with the cubic phase perovskite structure where the lattice parameter for NiO is (a=b=c =4.1695 Å) and BCZY is (a=b=c = 4.3170 Å). Other than that, the unit cell volume for NiO is 72.49 $Å^3$ and BCZY is 80.46 $Å^3$. The observation also shows that the lattice expansion is increasing with the temperature. The result obtained from the analysis, it shows that the crystallite size is also strongly correlated with the lattice expansion where it is proved that the crystallite size is increased when the temperature is increased.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Fuel cells are one of the great sustainable energy which uses electrochemical devices that convert chemical energy directly into electrical energy at extraordinarily high efficiency due to the lack of the Carnot constraint of the standard energy conversion chain. Moreover, fuel cells emit fewer pollutants and provide considerable scalability, allowing for energy generation ranging from mW to hundreds of kW while keeping more excellent performance (Fabbri et al., 2010). Solid oxide fuel cells (SOFC) have been one of the most valuable energy sources for the past few decades since they can convert chemical energy into electricity. SOFC is a type of energy conversion device that creates electricity by combining an oxidant and a fuel. SOFC is seen as a viable energy source because of its high-power generation efficiency.

Furthermore, this type of fuel cell uses a solid electrolyte and provides more energy conversion with reduced emissions, safer and more ecological friendly usage. As a suitable fuel for SOFCs, it is expected that it will be inexpensive, safe, and pollution-free, with no electrode contamination, and will be simple to store and transport (Lin et al., 2010). Somehow, SOFC needs a high operation temperature between 800-1000 °C that will cause a higher cost in building the device, which prevents it from extending its uses. Thus, to overcome this problem, many researchers have found that PCFC (proton ceramic fuel cells) is the best solution to reduce the cost because PCFC has a lower operating temperature than SOFC, making PCFC a great alternative for SOFC.