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Effect of Nb_2O_5 Addition to the Electrical Properties of Fe_2TiO_5 Ceramics-Based NTC Thermistor

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Functional Properties of Modern Materials

Risdiana, Kuwat Triyana and Agustinus Agung Nugroho

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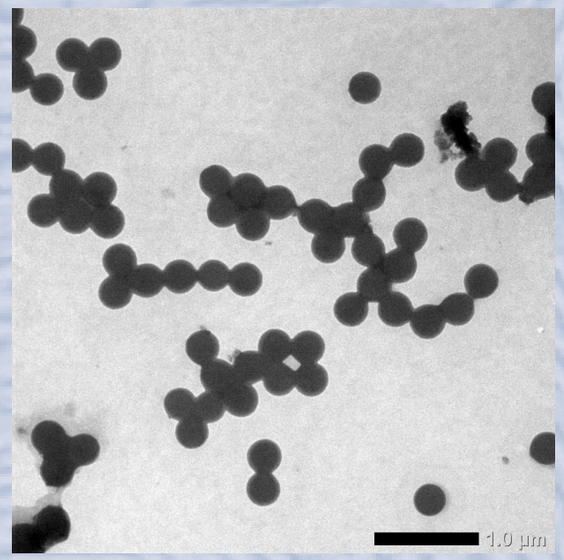

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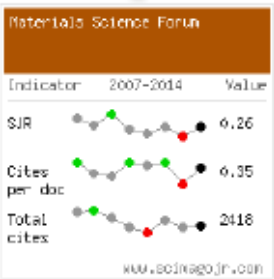

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Effect of Nb_2O_5 addition to the electrical properties of Fe_2TiO_5 ceramics-based NTC thermistor

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Abstract. The effect of Nb_2O_5 addition on the electrical properties of Fe_2TiO_5 ceramics-based NTC thermistor was studied. The concentration of Fe_2O_3 and TiO_2 was proportional to Fe_2TiO_5, whereas the concentration values of Nb_2O_5 were 0, 0.5 and 1.0 mole %, respectively. It can perceived from the XRD data that the sintered ceramics had single phase of Fe_2TiO_5, pseudobrookite. From SEM data, it is found that addition of Nb_2O_5 decreases the grain size. The addition of Nb_2O_5 increases thermistor constant, activation energy and room temperature resistance of Fe_2TiO_5 ceramics. The existence of Nb_2O_5 obstructed the growth of grain size so that the grain size will be decreased and the average of mean path will be increased. This causes the electrical resistance increased so that thermistor constant (B), activation energy (E_a), sensitivity (α) and room temperature resistance (R_{RT}) also increased with increasing the molar ratio of Nb_2O_5.

Introduction

Negative Temperature Coefficient (NTC) thermistor is a device that attracting research interest due to its potential application in many field such as biomedical, aerospace, instrumentation, communications, automotive and one package technology of HVACR (heating, ventilation, air conditioning, refrigeration) [1]. The NTC thermistor is generally made from ceramic having structure of spinel of AB_2O_4 where A is the ion that occupies tetrahedral position, and B is the ion that occupies octahedral position [2-6]. Although a report on NTC thermistor for higher temperature is available [5], the publication of the NTC thermistor with higher operation temperature made of Fe_2TiO_5 is not available so far. Compared with the traditional NTC thermistor material, Fe_2TiO_5 has higher bandgap that suitable for higher temperature operation. It is known that the working temperature of traditional thermistor is up to 100 ^oC [4]. However, high quality Fe_2TiO_5 ceramics with suitable electrical properties for wider application is still needed to be improved. Here, Nb_2O_5 is added to the Fe_2TiO_5 ceramics in order to get NTC thermistor having large value of thermistor constant, activation energy and electrical resistance. The aim of this study is to know the effect of Nb_2O_5 addition on the characteristics especially the electrical characteristics of the Fe_2TiO_5 ceramic for NTC thermistor.

Methodology

Powders of Fe_2O_3, TiO_2, and Nb_2O_5 were mechanically mixed with appropriate proportions to fabricate Nb_2O_5 added-Fe_2TiO_5 ceramics. The concentrations of Nb_2O_5 used in this study were 0, 0.5 and 1.0 mole %. The mixed powders were pressed with pressure of 4 ton/cm^2 to form pellets. The green pellets were sintered at 1300 ^oC for 2 hours in air.

The crystal structure of the sintered pellets was analyzed with x-ray diffraction (XRD) using Kα radiation at 40KV and 30mA. The microstructure of the pellets was investigated by scanning electron microscopy (SEM). Before electrical characterizations, the pellets were polished and