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Effect of Nb$_2$O$_5$ Addition to the Electrical Properties of Fe$_2$TiO$_5$ Ceramics-Based NTC Thermistor

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Wiendartun, **Risdiana**, Fitrilawati, R. E. Siregar
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Functional Properties of Modern Materials

Edited by
Risdiana
Kuwat Triyana
Agustinus Agung Nugroho
Functional Properties of Modern Materials

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Edited by

Risdiana, Kuwat Triyana and Agustinus Agung Nugroho
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Effect of Nb$_2$O$_5$ addition to the electrical properties of Fe$_2$TiO$_5$ ceramics-based NTC thermistor

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**Keywords:** Nb$_2$O$_5$, Fe$_2$TiO$_5$, Ceramics, NTC, Thermistor

**Abstract.** The effect of Nb$_2$O$_5$ addition on the electrical properties of Fe$_2$TiO$_5$ ceramics-based NTC thermistor was studied. The concentration of Fe$_2$O$_3$ and TiO$_2$ was proportional to Fe$_2$TiO$_5$, whereas the concentration values of Nb$_2$O$_5$ 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$_2$TiO$_5$, pseudobrookite. From SEM data, it is found that addition of Nb$_2$O$_5$ decreases the grain size. The addition of Nb$_2$O$_5$ increases thermistor constant, activation energy and room temperature resistance of Fe$_2$TiO$_5$ ceramics. The existence of Nb$_2$O$_5$ 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 ($\alpha$) and room temperature resistance ($R_{RT}$) also increased with increasing the molar ratio of Nb$_2$O$_5$.

**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$_2$O$_4$ 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$_2$TiO$_5$ is not available so far. Compared with the traditional NTC thermistor material, Fe$_2$TiO$_5$ has higher bandgap that suitable for higher temperature operation. It is known that the working temperature of traditional thermistor is up to 100 °C [4]. However, high quality Fe$_2$TiO$_5$ ceramics with suitable electrical properties for wider application is still needed to be improved. Here, Nb$_2$O$_5$ is added to the Fe$_2$TiO$_5$ 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$_2$O$_5$ addition on the characteristics especially the electrical characteristics of the Fe$_2$TiO$_5$ ceramic for NTC thermistor.

**Methodology**

Powders of Fe$_2$O$_3$, TiO$_2$, and Nb$_2$O$_5$ were mechanically mixed with appropriate proportions to fabricate Nb$_2$O$_5$ added-Fe$_2$TiO$_5$ ceramics. The concentrations of Nb$_2$O$_5$ 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 °C for 2 hours in air.

The crystal structure of the sintered pellets was analyzed with x-ray diffraction (XRD) using K$\alpha$ 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...