The Effect of SiO2 Addition on the Characteristics of CuFe2O4 Ceramics for NTC Thermistors

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INTRODUCTION

- **THERMISTOR**: Thermally Sensitive Resistor.
- **NTC CHARACTERISTIC**:

  ![Graph showing resistance vs. temperature for Thermistor, Resistance, and Thermocouple.](image)

**PRODUCT EXAMPLES:**

![Images of thermistor products.](image)
Important electronic component.
- Sectors: Biomedical, aerospace, instrumentation, communications, automotive and HVACR (Heating, Ventilation, Air conditioning and Refrigeration).
  - Application: Temperature measurement, circuit compensation, suppression of in rush-current, flow rate sensor and pressure sensor.

Most, thermistors are produced from spinel ceramics based on transition metal oxides forming general formula \( \text{AB}_2\text{O}_4 \).

Need alternative (Especially based on abundant material (mineral) in Indonesia) \( \rightarrow \) \( \text{CuFe}_2\text{O}_4 \) is proposed, including that added with \( \text{SiO}_2 \).

Predicted that the \( \text{SiO}_2 \) addition can improve the characteristics of the \( \text{CuFe}_2\text{O}_4 \) ceramic for NTC thermistors.
EXPERIMENT

MIXING

CuO  Fe₃O₄  SiO₂

CALCINATION

800°C/2h

CRUSHING

SIEVING

PRESSING

3,9 ton/cm²

SINTERING

1100°C/2h

CHARACTERIZATION

-XRD
-Electrical
-Microstructural

Sintering Furnace

XRD

Optical Microscope
RESULTS (XRD)

XRD profiles of CuFe$_2$O$_4$ based-ceramics.
RESULTS (Microstructure)

Microstructure of the CuFe$_2$O$_4$ based-ceramics.

- 0 w/o SiO$_2$
- 0.25 w/o SiO$_2$
- 0.75 w/o SiO$_2$

50 $\mu$m
RESULTS
(Electrical Characteristics)

Ln resistivity (ρ) vs 1/T of SiO₂ added- CuFe₂O₄ ceramics.
# RESULTS

(Electrical Characteristics)

<table>
<thead>
<tr>
<th>No.</th>
<th>Additive of SiO(_2) (w/o)</th>
<th>B ((^\circ)K)</th>
<th>(\alpha) (%/(^\circ)K)</th>
<th>(\rho_{RT}) (Ohm-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0.00</td>
<td>2548</td>
<td>2.83</td>
<td>291</td>
</tr>
<tr>
<td>2.</td>
<td>0.25</td>
<td>2358</td>
<td>2.62</td>
<td>1079</td>
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<tr>
<td>3.</td>
<td>0.50</td>
<td>2884</td>
<td>3.20</td>
<td>4788</td>
</tr>
<tr>
<td>4.</td>
<td>0.75</td>
<td>3308</td>
<td>3.68</td>
<td>9400</td>
</tr>
</tbody>
</table>

Market requirement for B is \(\geq 2000\) °K and \(\alpha\) is \(\geq 2.2\) \%/°K\(^\circ\)K\(^\circ\)K[7], market requirement for \(\rho_{RT} = 10\) ohm.cm -1 Mohm.cm [4].
CONCLUSIONS

- The CuFe$_2$O$_4$ ceramics can be applied as NTC Thermistor.
- The grain size of the CuFe$_2$O$_4$ ceramics tends to decrease by addition of SiO$_2$.
- The addition of SiO$_2$ increased the room temperature resistivity ($\rho_{RT}$) and the thermistor constant (B) of the CuFe$_2$O$_4$ ceramics due to the segregated SiO$_2$.
- The value of ($\rho_{RT}$) and (B) of the CuFe$_2$O$_4$ ceramics made in this work fits the market requirement.
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