Synthesis and Characterization of TiO_2 Added-$ZnFe_2O_4$ Ceramics for NTC Thermistors

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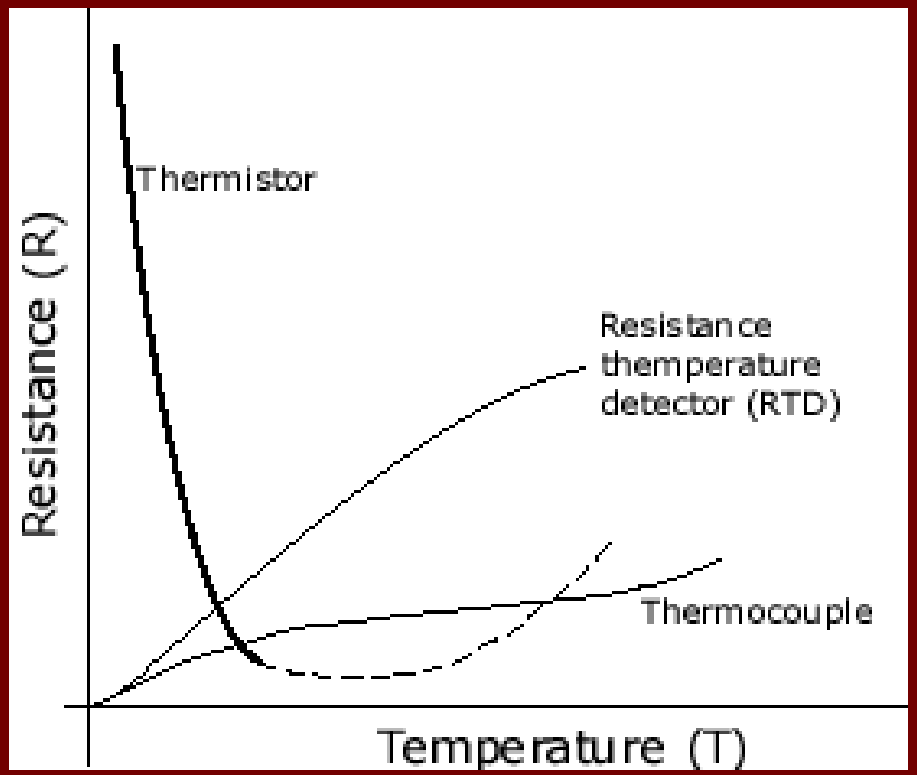
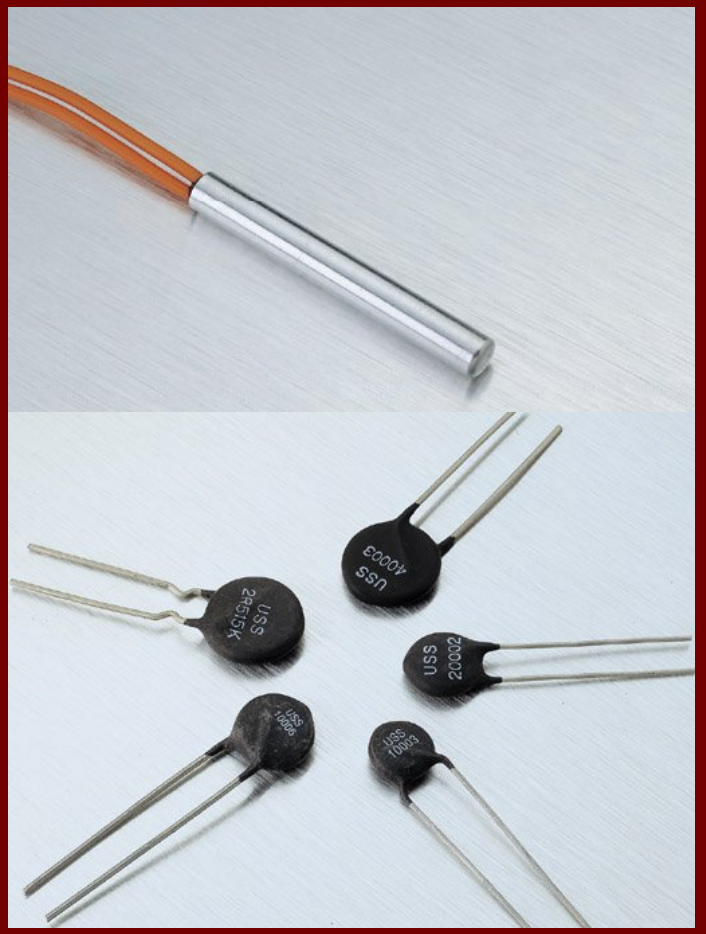
INTRODUCTION

- THERMISTOR→ Thermally Sensitive Resistor.
- NTC CHARACTERISTIC :



PRODUCT EXAMPLES:



INTRODUCTION (Continuation)

- 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 AB_2O_4.
- Need alternative (especially based on abundant material in Indonesia, e.g. hematite)→ $ZnFe_2O_4$ is proposed, including that added with TiO_2.
- Predicted that the TiO_2 addition can improve the characteristics of the $ZnFe_2O_4$ ceramic for NTC thermistors.

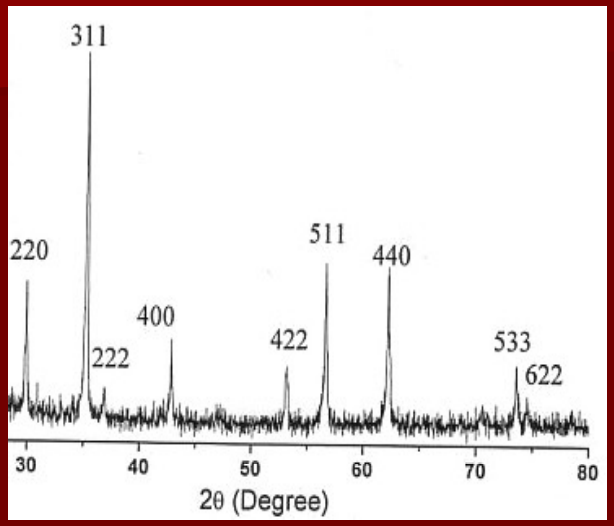
EXPERIMENT

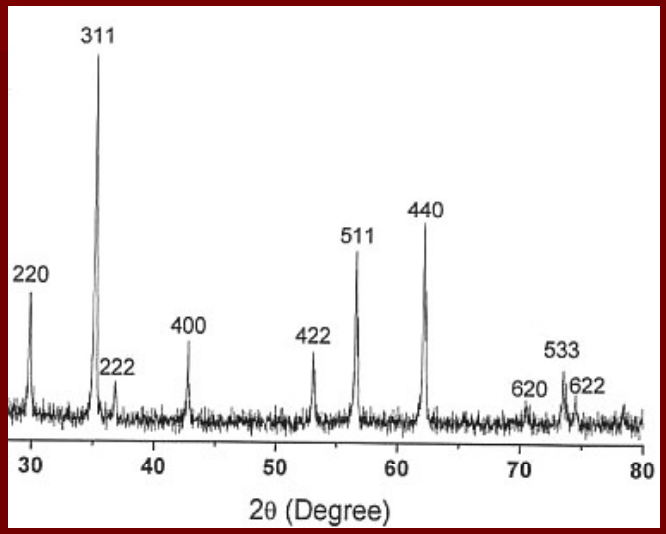
Sintering Furnace

Optical Microscope

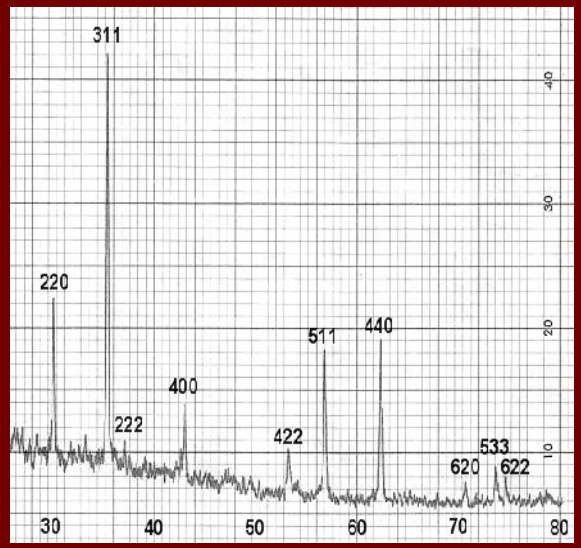
RESULTS (XRD)

0 w/o TiO_2





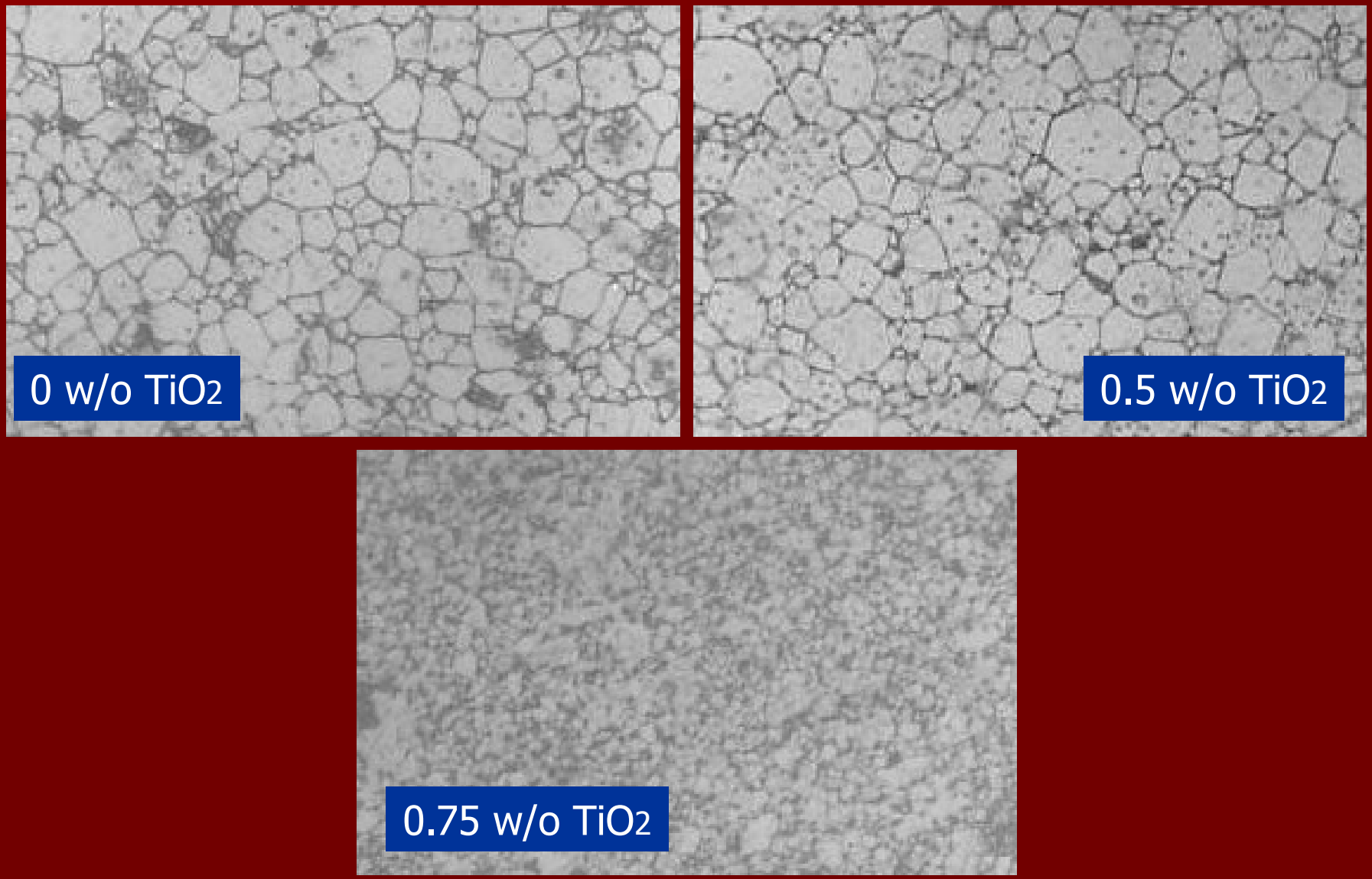
0.5 w/o TO_2



0.75 w/o TiO_2

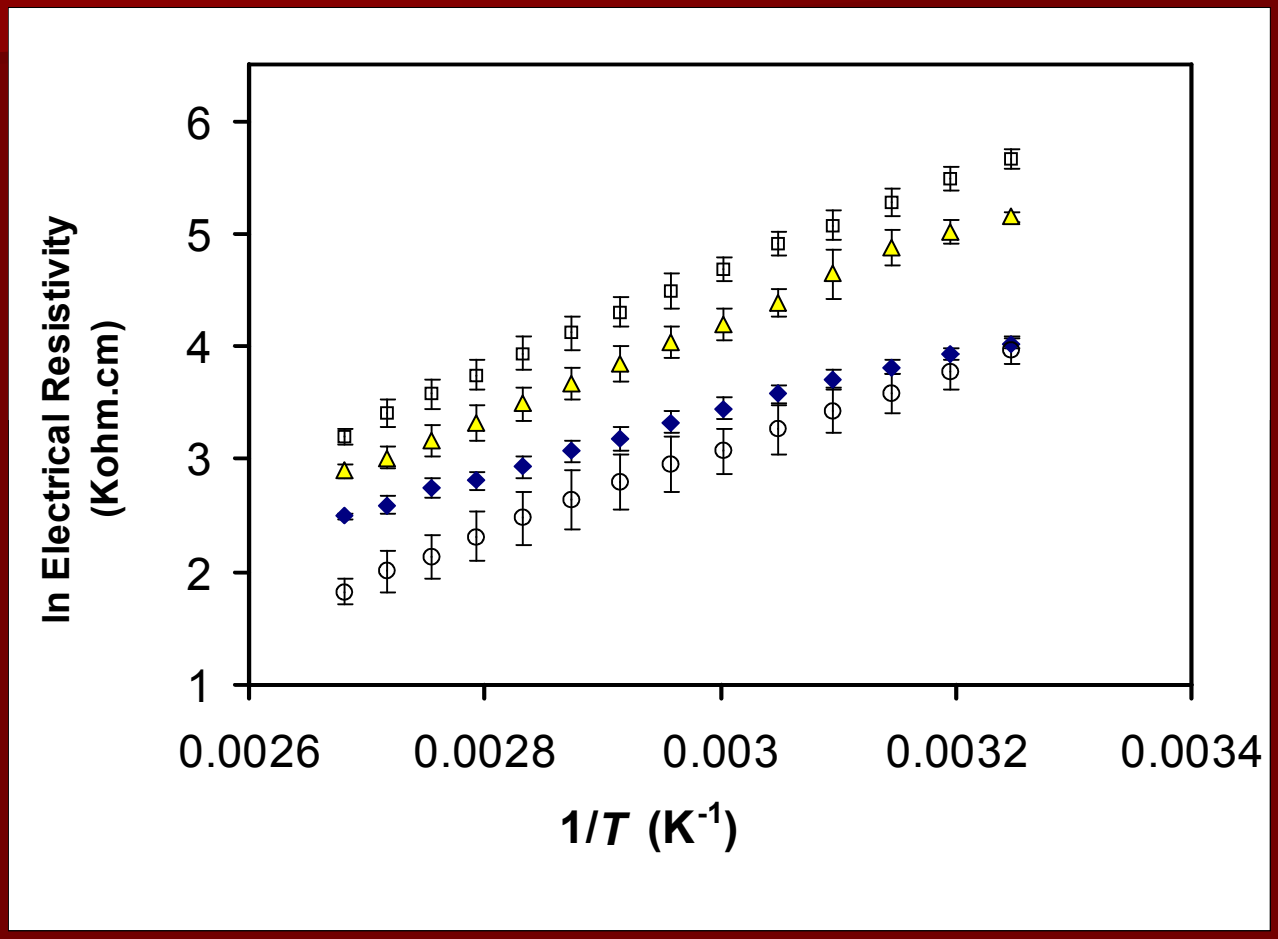
XRD profiles of $ZnFe_2O_4$ based-ceramics.

RESULTS (Microstructure)



Microstructures of the $ZnFe_2O_4$ based-ceramics.

RESULTS (Electrical Characteristics)



♦ 0 w/o TiO_2
O 0.25 w/o TiO_2
Δ 0.50 w/o TiO_2
□ 0.75 w/o TiO_2

Ln resistivity (ρ) vs $1/T$ of TiO_2 added- $ZnFe_2O_4$ ceramics.

RESULTS (Electrical Characteristics)

No.	Additive of TiO_2 (w/o)	B (^oK)	α (%/^oK)	ρ_{RT} (Kohm-cm)
1.	0	2781	3.09	81
2.	0.25	3721	4.14	81
3.	0.50	4164	4.63	293
4.	0.75	4350	4.83	493

No.	TiO_2 (w/o)	Ea (eV)
1.	0	0.24
2.	0.25	0.32
3.	0.50	0.36
4.	0.75	0.38

Market requirement for B is ≥ 2000 ^oK and α is ≥ 2.2 %/oK, and Ea is 0.1 -1.5 eV [7], market requirement for ρRT = 10 ohm.cm-1 Mohm.cm [4].

CONCLUSIONS

- The $ZnFe_2O_4$ ceramics can be applied as NTC thermistor.
- The grain size of the $ZnFe_2O_4$ ceramics tends to intact by addition of TiO_2 up to 0.5 w/o and decreases abruptly at the TiO_2 concentration of 0.75 w/o.
- The abruptly change is caused by the segregation of the added TiO_2 at grain boundaries which inhibited grain growth during sintering.
- A part of the added TiO_2 may be dissolved in $ZnFe_2O_4$ ceramics.
- The addition of TiO_2 increases the room temperature resistivity (ρRT) and the thermistor constant (B) of the $ZnFe_2O_4$ ceramics due to the segregated TiO_2.
- The TiO_2 concentration of 0.25 w/o seems to be the best one in low room temperature resistivity application point of view.
- The value of (ρRT) and (B) of the $ZnFe_2O_4$ ceramics made in this work fits the market requirement.

THANK YOU