Electrical Characteristics of $CuFe_2O_4$ Thick Film Ceramics With Different Glass Frit Concentrations Fired at 1000 °C for Negative Thermal Coefficient (NTC) Thermistor

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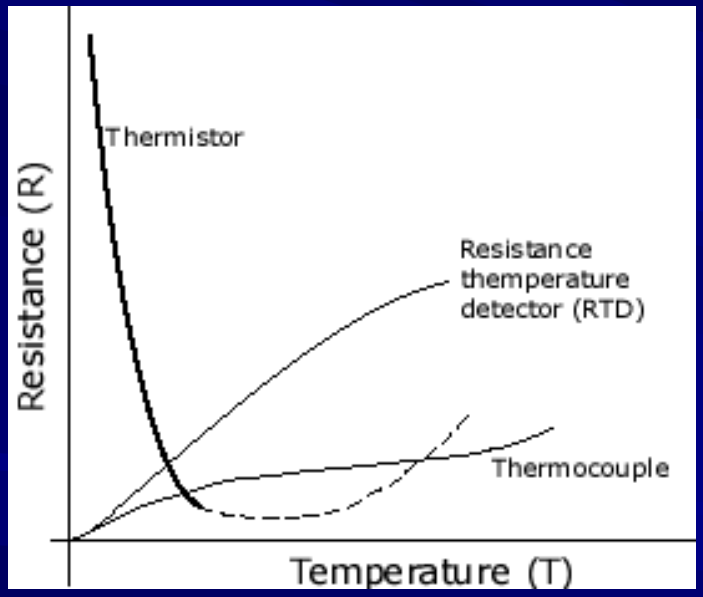
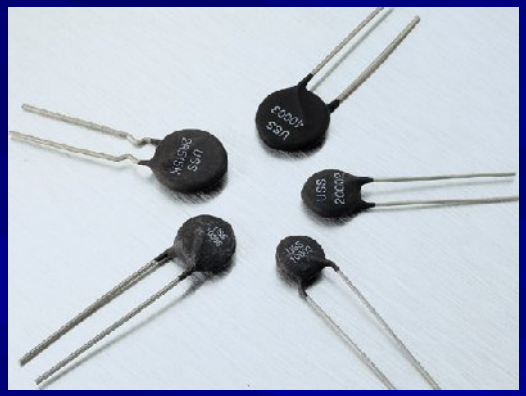
INTRODUCTION

THERMISTOR→ Thermally Sensitive Resistor.
NTC CHARACTERISTIC PRODUCT EXAMPLES APPLICATIONS

R vs T- THERMISTOR

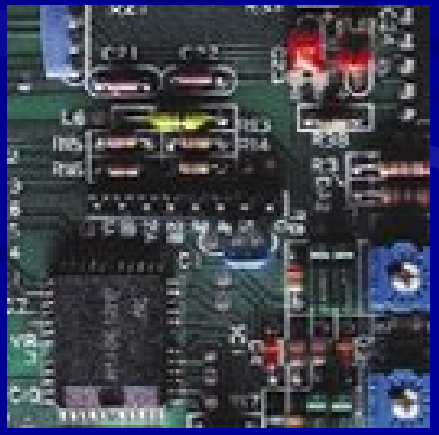




Current limiter thermistor

Specialize Thermistor

Incubator



Computer

INTRODUCTION (Continuation)

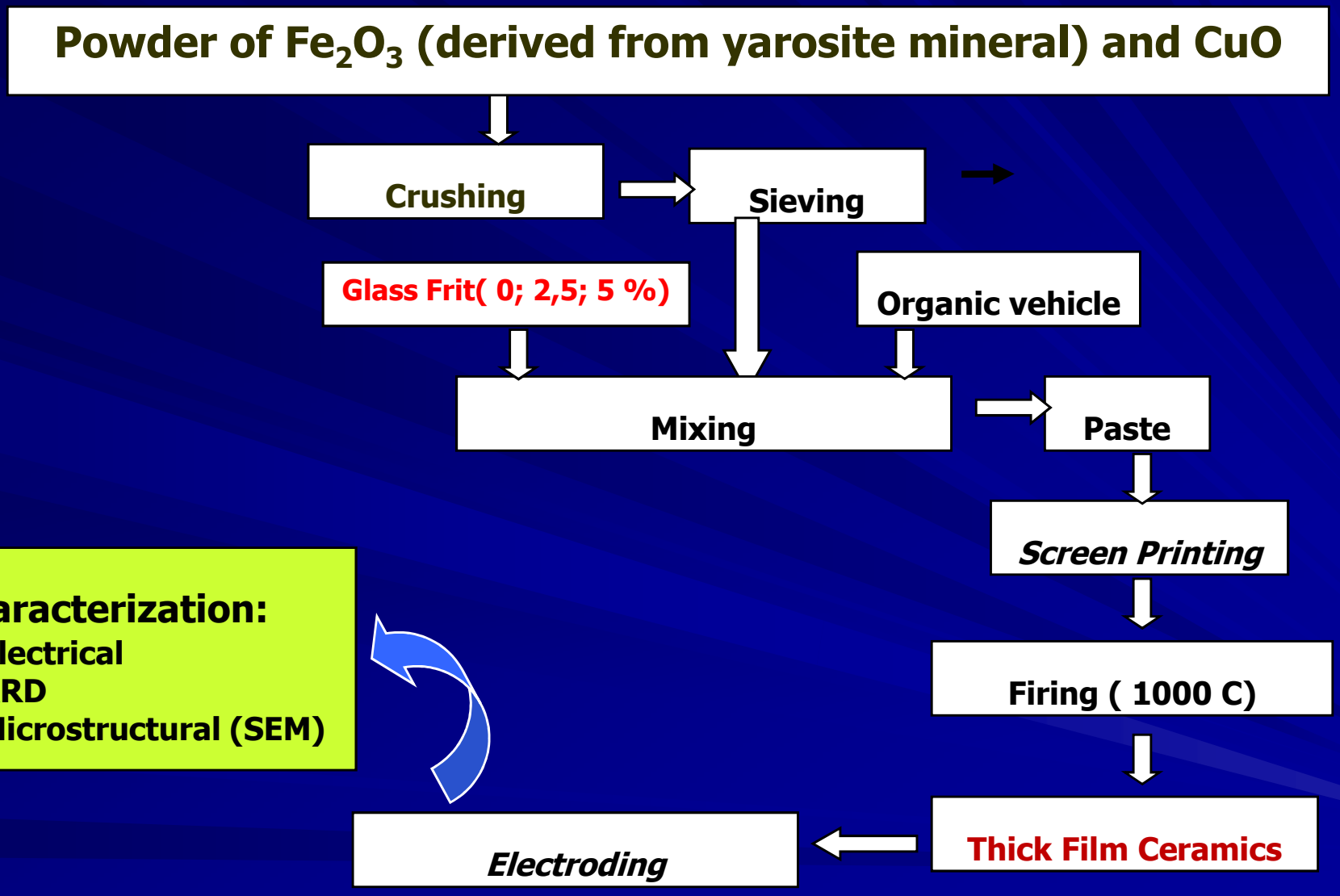
- **Important electronic component.**
  - **Sectors: Biomedical, aerospace, instrumentation, communications, automotive and HVACR (Heating, Ventilation, Air conditioning and Refrigeration).**
  - **Application : Temperature sensor measurement, current limiter, circuit compensation, suppression of in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

- **It is necessary to get capability in self producing thermistor by utilizing material abundant in Indonesia such us yarosite mineral (Fe_2O_3) → $CuFe_2O_4$ based-thick film for NTC Thermistor, with** glass frit concentration (0; 2,5 ;5 weight %)

- **The thermistor in the form of thick film is possible for miniaturization and integration . Advantages : more practical, profitable economically, need a few material, and fired at law temperature.**

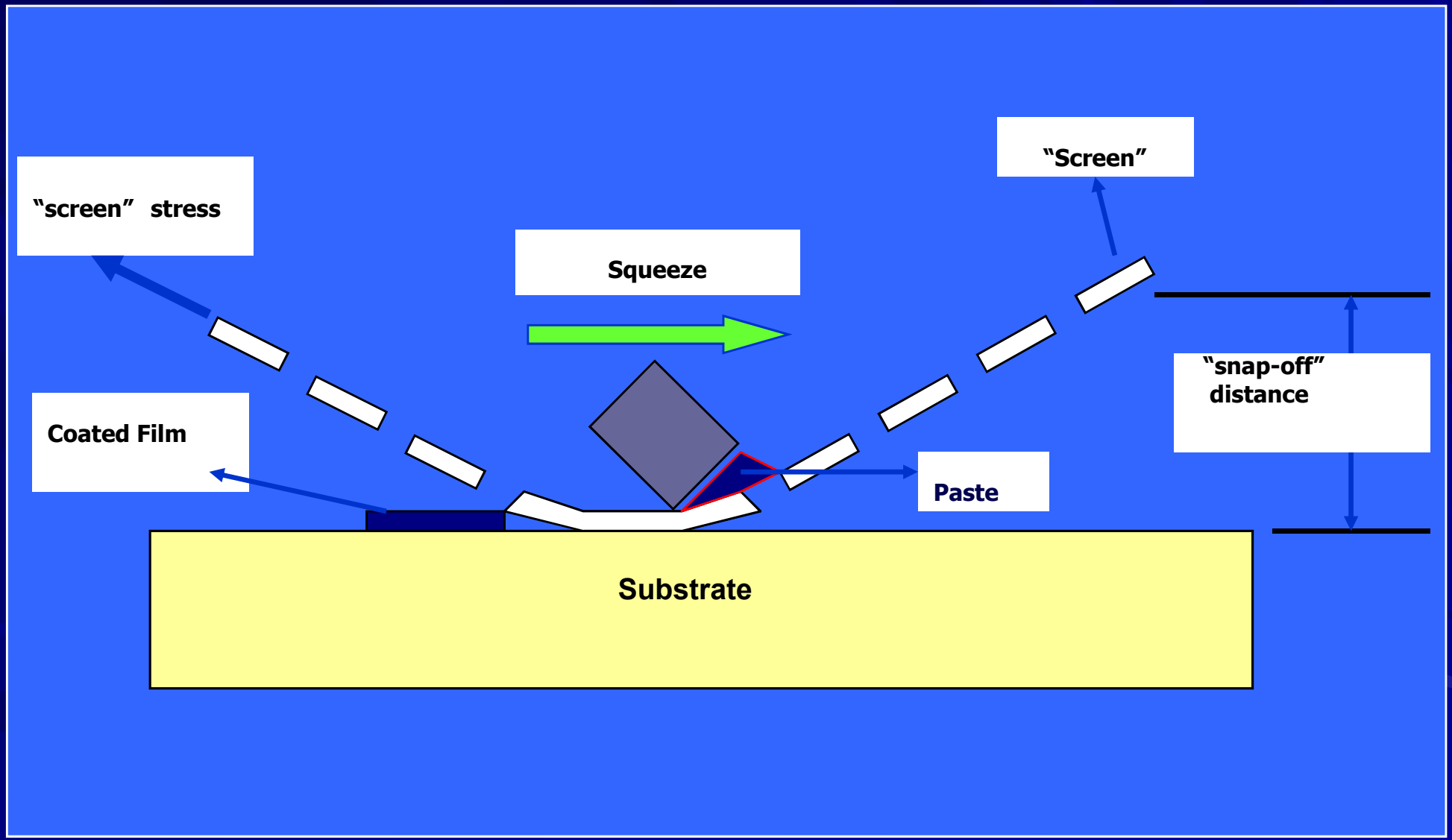
YAROSITE MNERAL

EXPERIMENT :



Flow diagram of the experiment procedure.

SCREEN PRINTING



Electrical Characteristic

- $R = R_0 . \text{Exp.}(B/T)$
- $\text{Ln } R = B/T + \text{Ln Ro}$
  - $Ea = B.k$
  - $\alpha = - B/T^2$

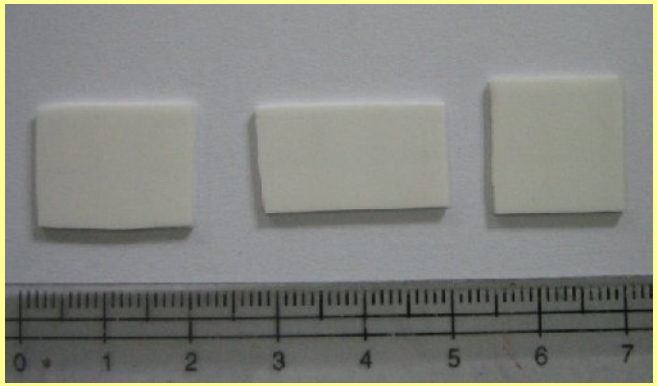
R = Thermistor resistance
R_o = Resistance at the infinite temperature
B = Thermistor constant
T = Temperature of thermistor in Kelvin
Ea = Activation energy
K = The Boltzmann constant
A = Sensitivity of thermistor

RESULT :
Chemical composition of Fe_2O_3 powder derived from yarosite table

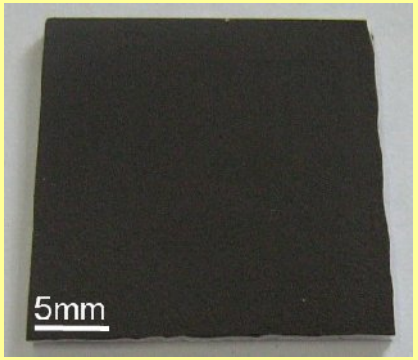
No.	Component	Concentration (Weight %)
1	**Fe_2O_3**	**93.80**
2	Al_2O_3	2.54
3	SiO_2	1.15
4	TiO_2	1.02
5	MgO	0.19
6	K_2O	0.12
7	CaO	0.59
8	Na_2O	0.50
9	MnO	0.09

RESULT
Thick Film (yarosite)

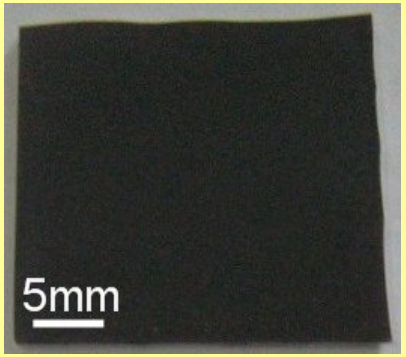
Visual appearance



Alumina Substrat

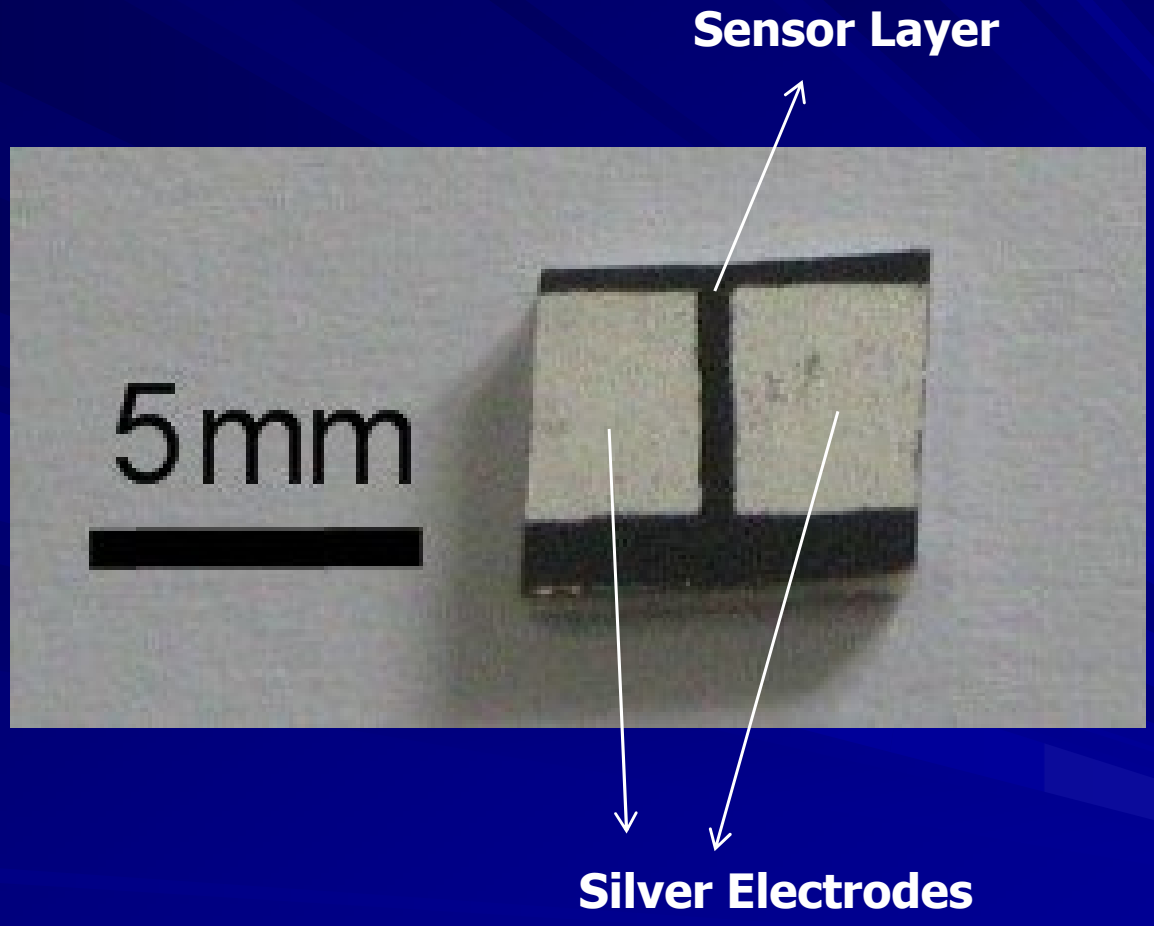


Thick film before fired

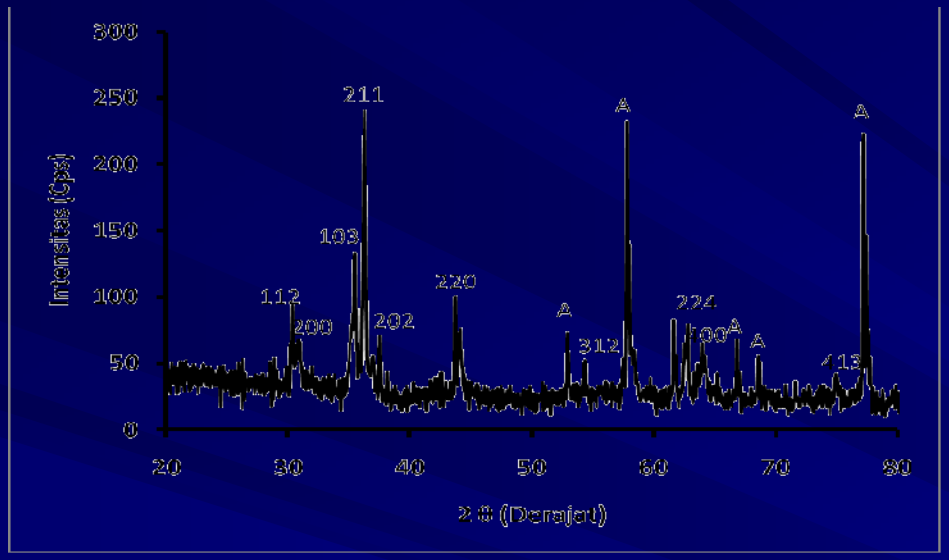


Thick film fired at 1100 C/1 hr

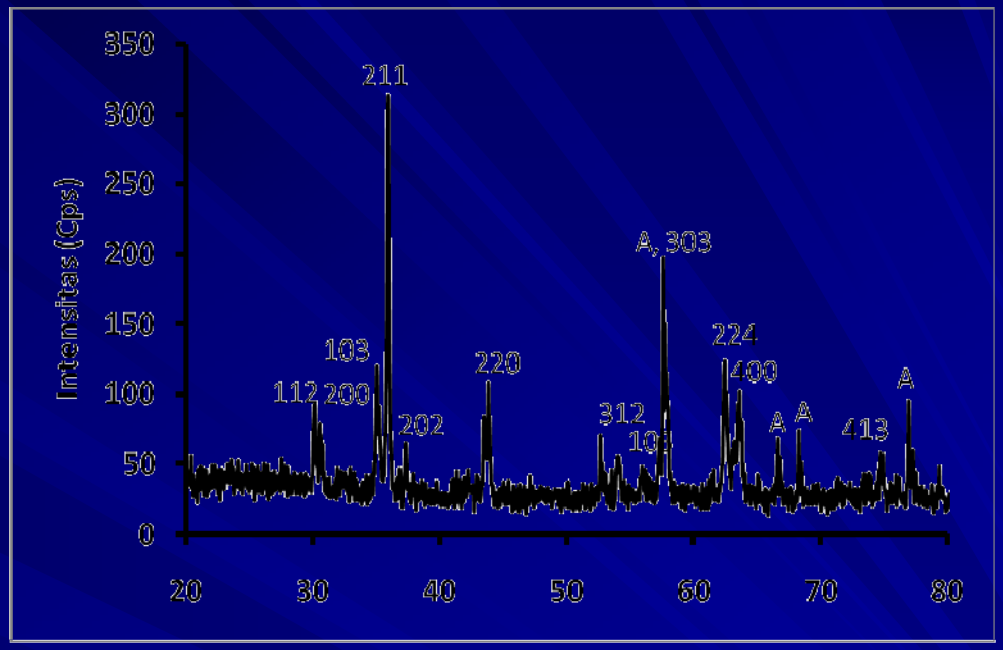
A typical thick film thermistor



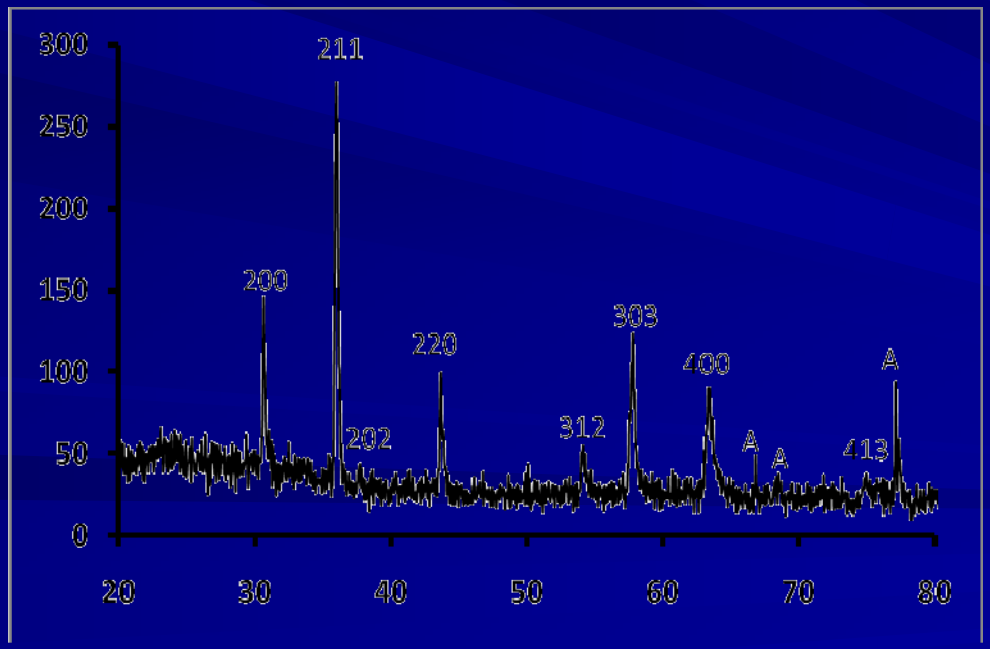
RESULT (XRD)



(without glass frit concentration)



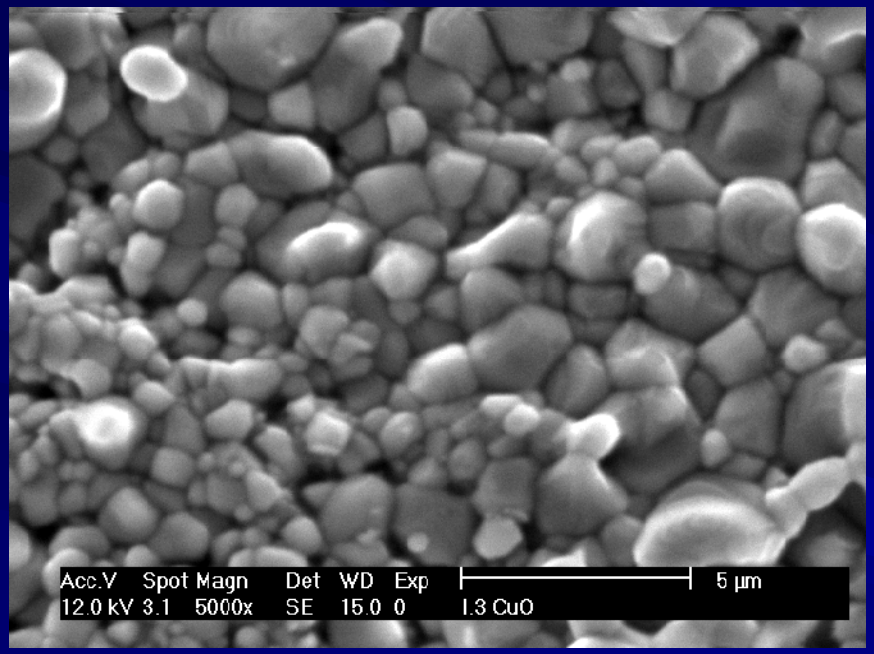
(with 2,5 % glass frit concentration)



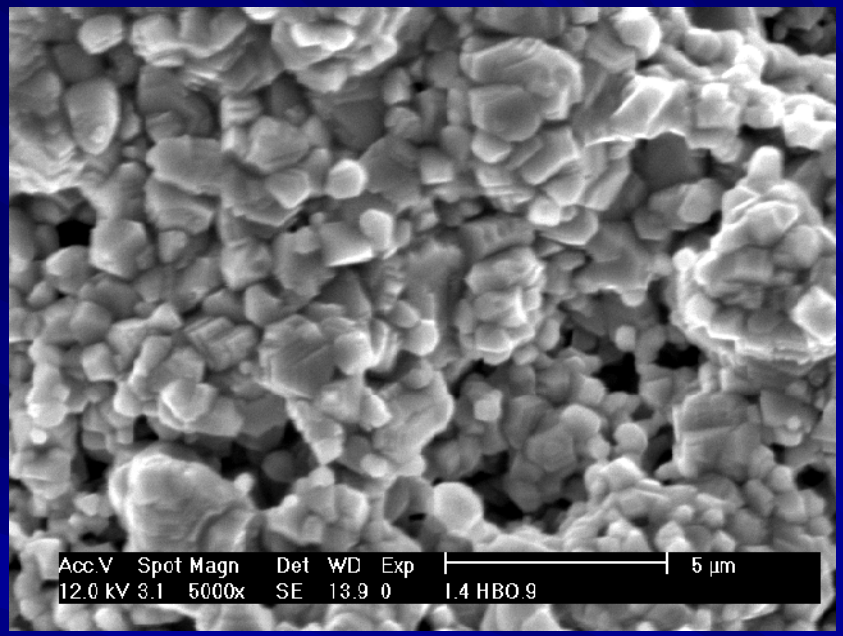
(with 5,0 % glass frit concentration)

XRD profile of $CuFe_2O_4$ based-thick film

RESULTS (Microstructure)



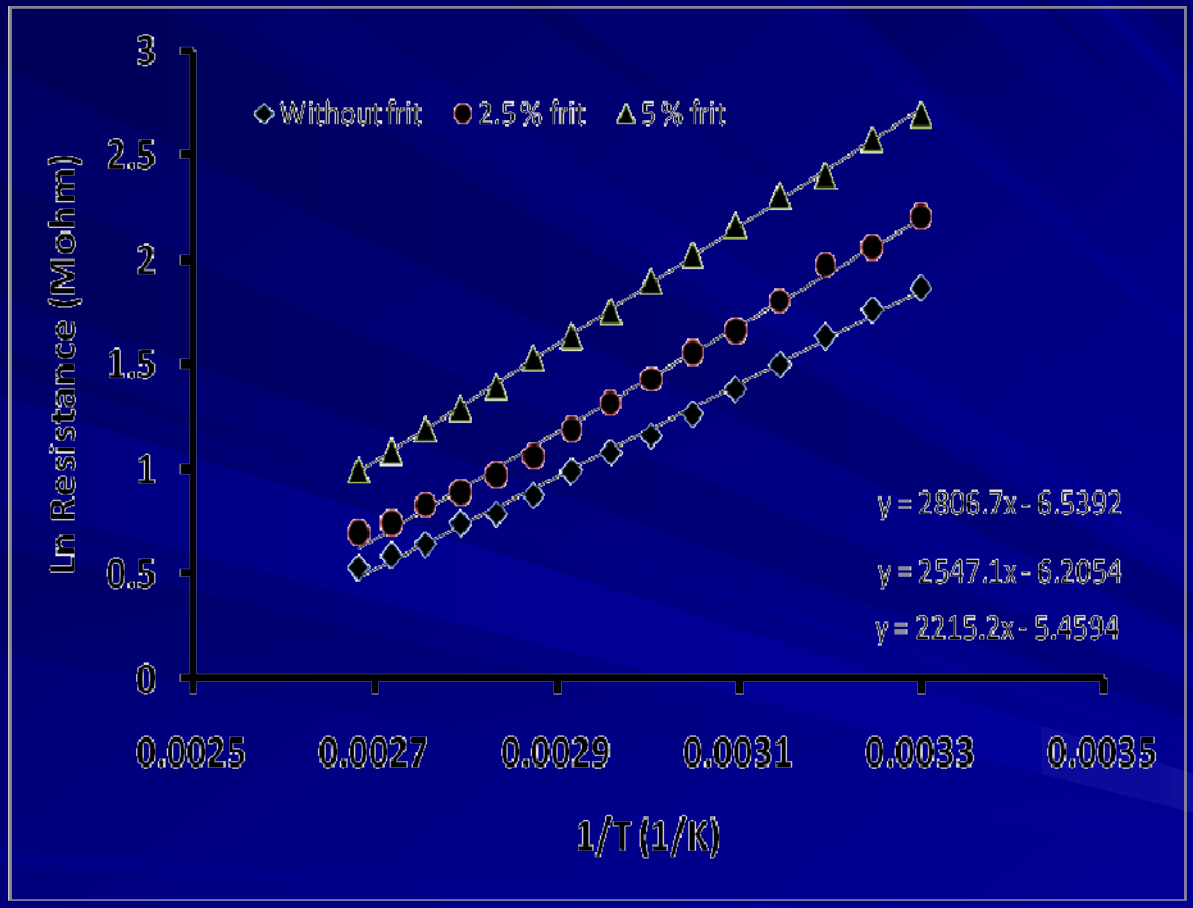
(without glass frit concentration)



(with 2,5 % glass frit concentration)

Microstructure of the $CuFe_2O_4$ thick film

RESULTS
(Electrical Characteristics)



The relation between ln Electrical Resistivity and 1/T of $CuFe_2O_4$ based-thick film fired at 1000oC for 1 hr (with : 0; 2,5 , 5% glass frit concentration)

Ln resistivity (ρ) vs $1/T$ of $CuFe_2O_4$ thick film ceramics.

RESULTS
(Electrical Characteristics)

Table of electrical characteristics of $CuFe_2O_4$ thick film ceramics

(with : 0; 2,5 , 5% glass frit concentration)

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No.	Frit (%)	B (K)	Alfa (%/K)	R_{SR} (Mohm)	
1.	0	2215	2,46	6,9	
2.	2,5	2547	2,83	9,8	
3.	5	2807	3,12	16,7	

Market requirement for :

B is ≥ 2000 ^oK

α is ≥ 2.2 %/^oK[7]

ρ_{RT} = 10 ohm.cm -1 Mohm.cm [4].

CONCLUSIONS

- $CuFe_2O_4$ thick film ceramics utilizing Fe_2O_3 derived from yarosite mineral have been well fired at 1000^oC for 1 hour. with : 0; 2,5 , 5% glass frit concentration.
- All of the thick films crystallize in tetragonal spinel.
- The SEM images showed that the effects of glass frit concentration make the grain size was smaller..
- Electrical data showed that the larger the glass frit concentration, the larger the : resistance, thermistor constant and sensitivity.
- The value of thermistor constant (B) = 2215-2807^oK and room temperature resistance (R_{RT}) = 6,9-16,7 MOhm of the produced $CuFe_2O_4$ ceramics fitted market requirement.

THANK YOU

ACKNOWLEGMENT

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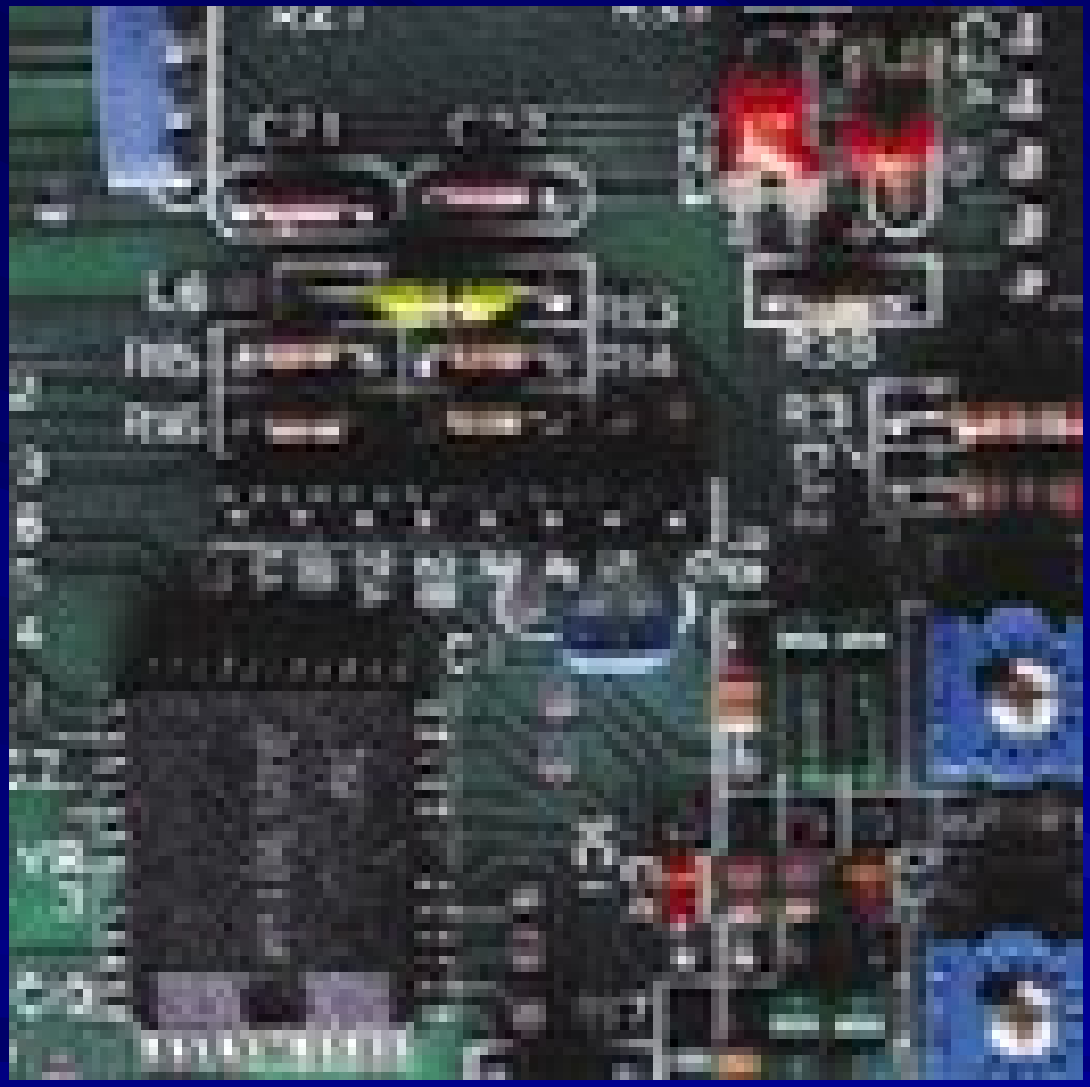
LAMPIRAN
APLIKASI THERMISTOR-1

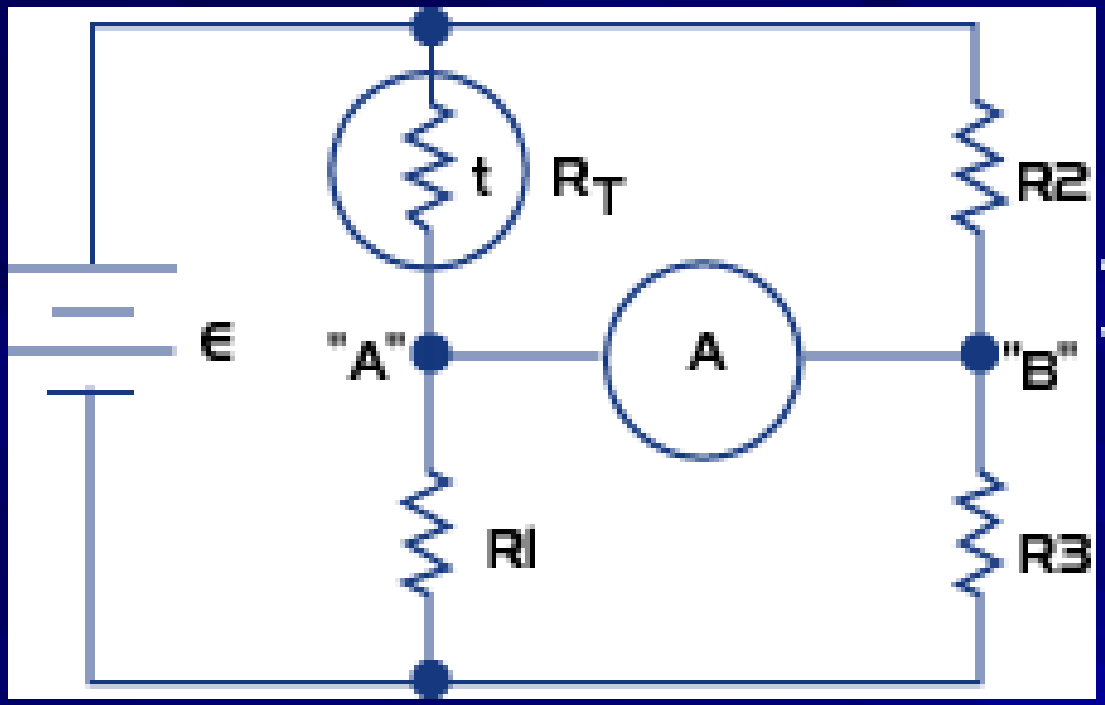
Inkubator Bayi

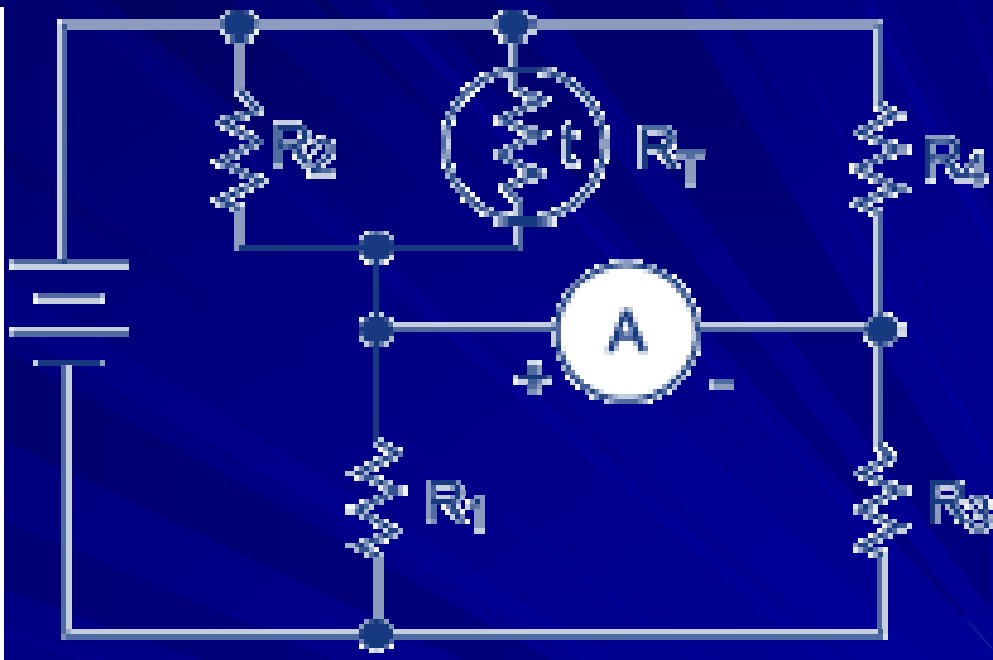
APLIKASI THERMISTOR-2



Komputer

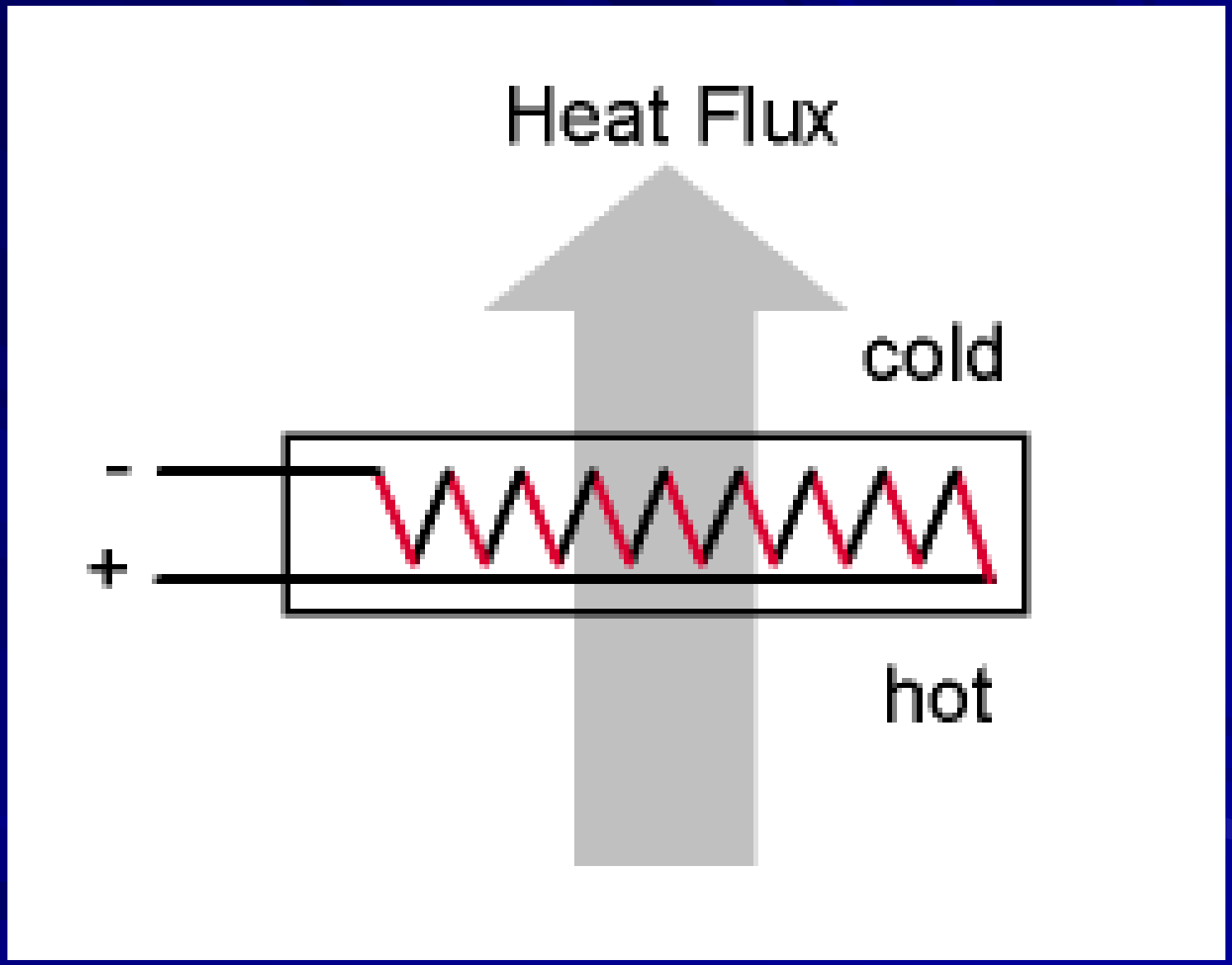
APLIKASI THERMISTOR-3





Pengukur suhu

APLIKASI THERMISTOR-4



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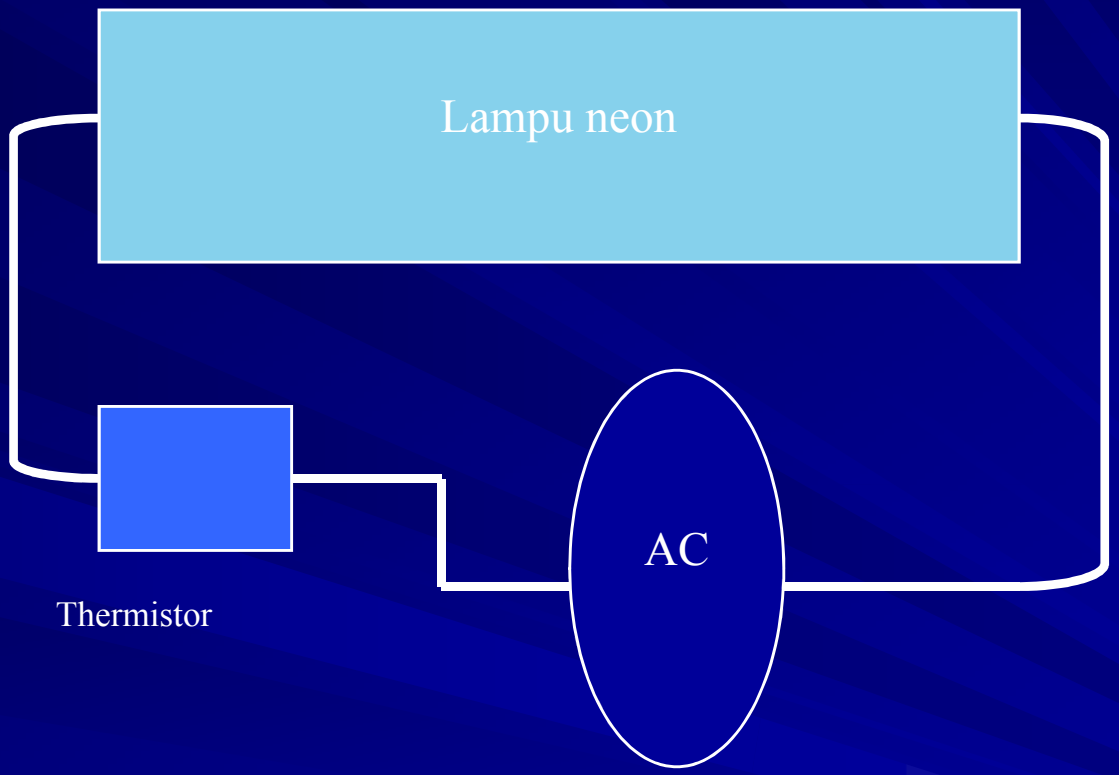
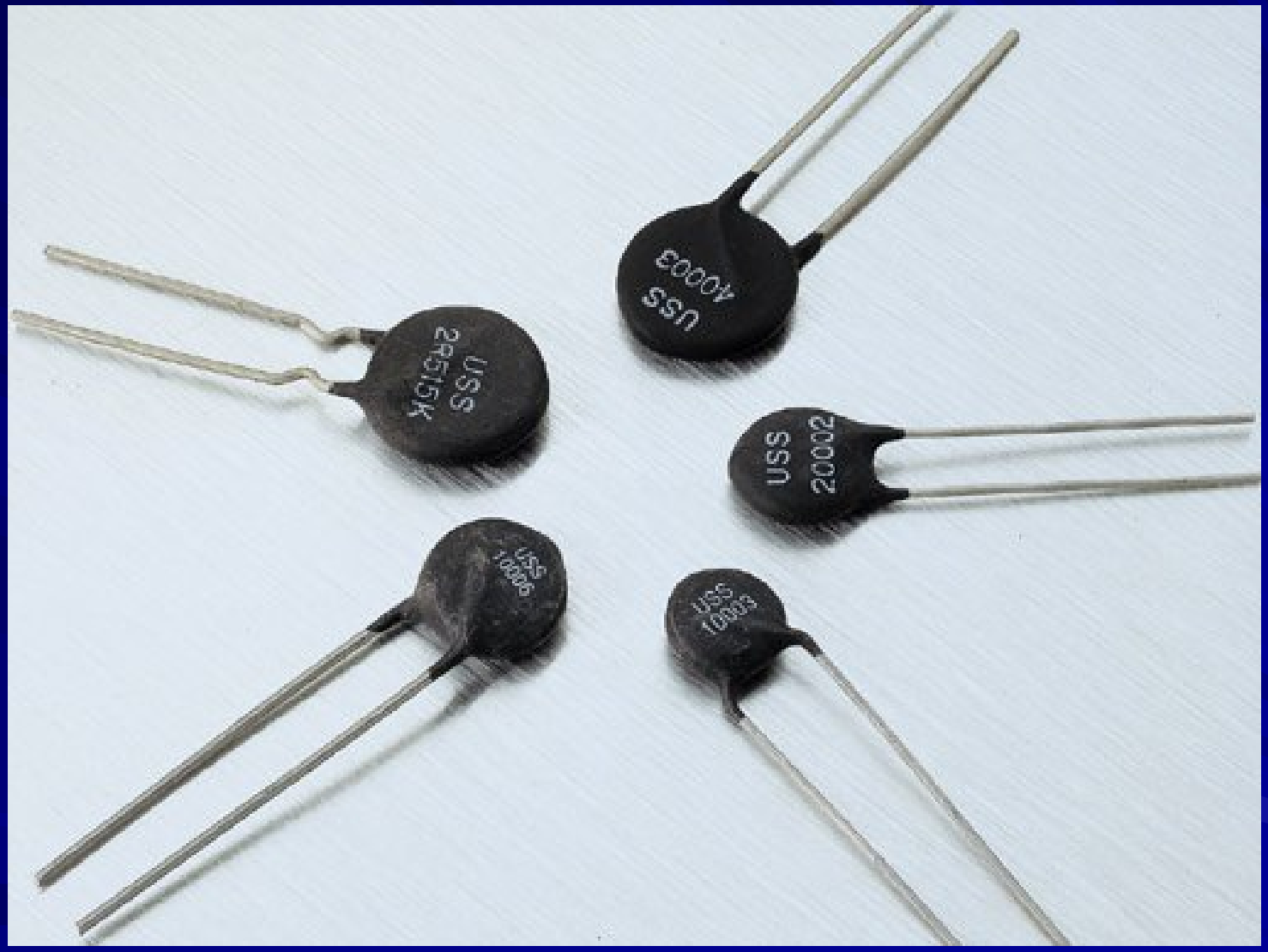


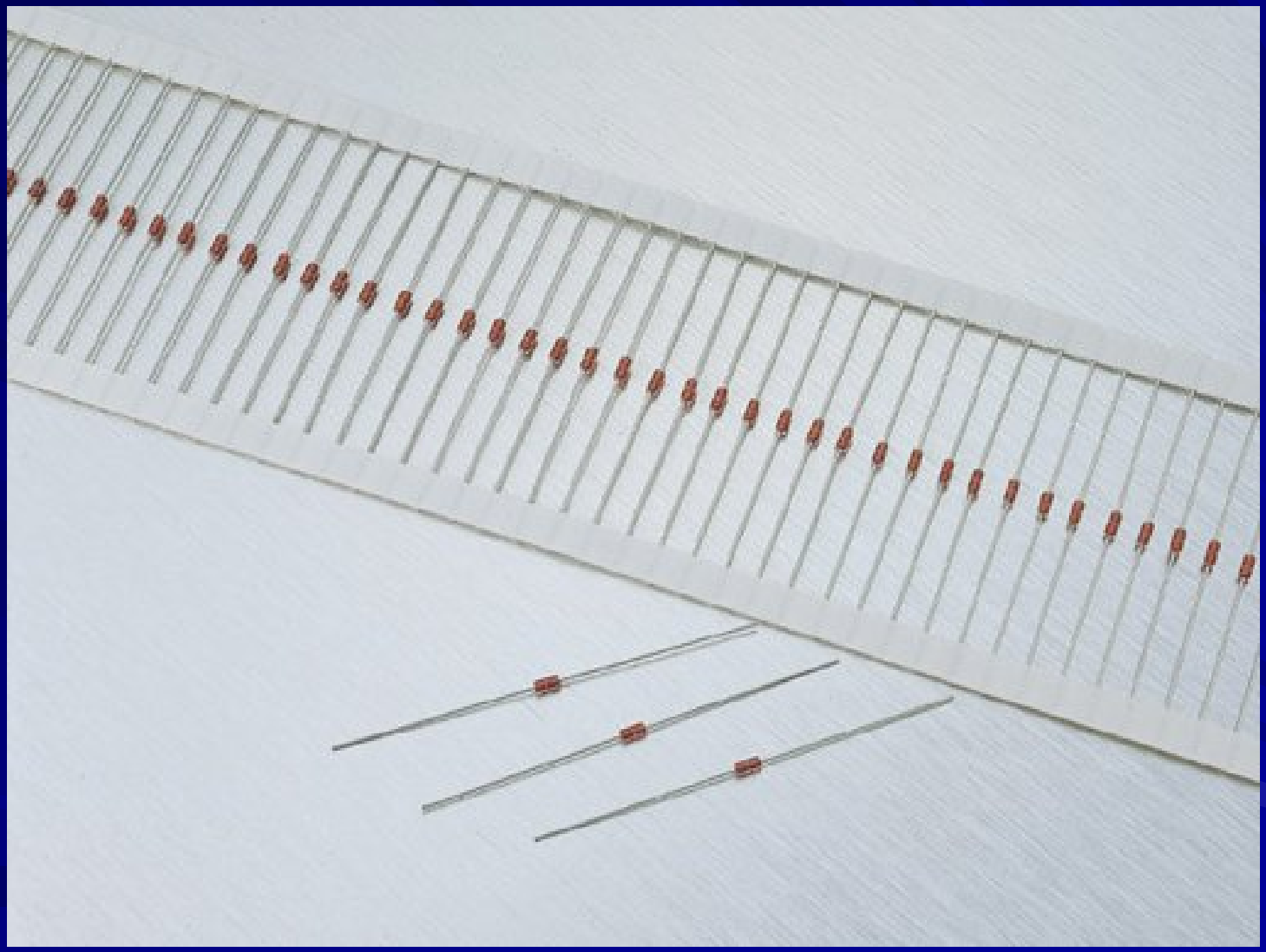
Pembatas Arus Listrik

BENTUK THERMISTOR-1



Thermistor Pembatas Arus

BENTUK THERMISTOR-2



Thermistor Gelas

BENTUK THERMISTOR-3

Thermistor Khusus

BENTUK THERMISTOR-4

Thermistor Lead Epoxy