Dispersion of dielectric constant and resistivity of 
$\text{Cu}_x \text{Zn}_{1-x} \text{Fe}_2 \text{O}_4$ samples

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MS received 24 April 1981; revised 1 September 1981

Abstract. $\text{Cu}_x \text{Zn}_{1-x} \text{Fe}_2 \text{O}_4$ samples exhibit dispersion of dielectric constant, $\tan \delta$ and resistivity in the frequency range of 1 kHz to 50 MHz. The dispersion exhibited is in general accord with Koops' model. However, the details of the conducting and non-conducting regions must be taken into account when composition tends to change interrelationship between the elementary capacitor resistor circuits.

On quenching these samples from 800°C the dielectric constant $\varepsilon'$ showed an increase for $\text{CuFe}_2 \text{O}_4$ and $\text{Cu}_{0.8}\text{Zn}_{0.2} \text{Fe}_2 \text{O}_4$ samples. The dielectric constant of the remaining samples showed no influence on quenching. The compositional variation showed that the dielectric constant has higher value for the ferrite $\text{Cu}_{0.4}\text{Zn}_{0.6} \text{Fe}_2 \text{O}_4$.

The results are explained on the basis of cation transfer.

Keywords. Dispersion; quenching; interfacial polarisation; dielectric constant.

1. Introduction

Ferrites show abnormally high dielectric constant and dispersion of dielectric constant and resistivity (Kamiyoshi 1951). The dispersion is explained by Koops (1951) and Moltgen (1952) to be due to inhomogeneous dielectric structure suggested by Maxwell (1873) and Wagner (1915).

The Koops model does not give details of the conducting and non-conducting regions. These studies are therefore essential.

In the present paper we report our studies on dielectric constant, resistivity and $\tan \delta$ for $\text{Cu}_x \text{Zn}_{1-x} \text{Fe}_2 \text{O}_4$ samples in the frequency range of 1 kHz to 50 MHz. The dielectric constants of the samples of $\text{Cu}_x \text{Zn}_{1-x} \text{Fe}_2 \text{O}_4$ quenched from 800°C are also presented.

2. Experimental

Samples of $\text{Cu}_x \text{Zn}_{1-x} \text{Fe}_2 \text{O}_4$ ($x = 0, 0.2, 0.4, 0.6, 0.8$ and $1$) were prepared by standard ceramic method. Weighed quantities of AR grade oxides of CuO, ZnO and
Fe₂O₃ were calcinated at 700°C for 24 hr. Powders of these oxides were fired to 950°C for 24 hr and furnace cooled at the rate of 80°C/hr. Pellets of 1 cm diameter and 2 mm thickness were prepared and sintered at a temperature 950°C for 8 hr and furnace cooled at the rate of 80°C/hr. Retaining a series of CuₓZn₁₋ₓFe₂O₄ as slow cooled, quenching in air of the samples from 800°C was carried out. The LCR bridge TF 1245 (series) —circuit magnification meter— Marconi Instruments were used for measurements of resistivity and dielectric constant in the range 40 kHz up to 50 MHz. For low frequency measurements Marconi—TF 2700 LCR bridge was used.

3. Result and discussion

Figure 1 shows variation of dielectric constant $\varepsilon'$ as a function of frequency for the samples of CuₓZn₁₋ₓFe₂O₄. It is observed that as the frequency increases the dielectric constant decreases. The dispersion of dielectric constant is similar for all the samples.

Figure 2 shows variation of $\tan \delta$ against the frequency for these samples. Though the nature of the variation for all the samples is similar, the peaks observed change differently lying between $10^5$ Hz to $10^6$ Hz. The nature of the graph is as expected and agrees well with that reported for other ferrites (Iwauchi 1971; Murthy and Sobhanandri 1975).

Figure 3 shows variation of resistivity as a function of frequency. The resistivity also shows dispersion. Table 1 gives values of $\varepsilon'$ for CuₓZn₁₋ₓFe₂O₄ slow cooled and quenched samples obtained from the experiment.

![Figure 1. Dielectric constant variation with log F.](image-url)