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Microwave Attenuation Characteristics of Co-Cr Doped Barium-Strontium Hexaferrite

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Abstract— **In the present investigation, the microwave/electromagnetic attenuation properties of Co-Cr doped $Ba_{0.5}Sr_{0.5}Fe_{(12-2x)}O_{19}$ hexaferrite have been reported. Vector Network analyzer (VNA) is being utilized to test the attenuation parameters at X-band. Co-Cr ions render increase in microwave attenuation with composition x=0.8 having maxima of 47.91 dB at 9.208 GHz.**

Keywords— Attenuation, Ferrites, Microwave Absorption, Eddy current etc.

INTRODUCTION

The extensive application of wireless devices/technology has created the web of wireless signals everywhere in the world. Besides the various applications of wireless devices such as mobile phone, Wi-Fi, satellite communication etc. the wireless signals have started to interfere with various electrical/electronic devices in the form noise signal or electromagnetic interference. Consequently, the devices start malfunctioning while being in the influence of undesirable wireless signal or electromagnetic interference. Hexagonal ferrites are extensively used for the suppression of microwave signal owing to their inherent properties. [1-4].

EXPERIMENTAL

Co-Cr doped M-type $Ba_{0.5}Sr_{0.5}Fe_{12}O_{19}$ hexaferrite compositions were prepared by ceramic method and 6 compositions were prepared by varying the content of Co-Cr (x=0.0, 0.2, 0.4, 0.6, 0.8 and 1.0) [5-7]. The complex permittivity and complex permeability were calculated with the help of S-parameters measured by VNA (Agilent model number N5225A) .

RESULTS AND DISCUSSION

Microwave attenuation of signal can be expressed with below relation:

$$\alpha = (\sqrt{2}\pi/\lambda_o) * \{ \varepsilon'' * \mu'' - \varepsilon' * \mu' + [(\varepsilon'' * \mu'')^2 + (\varepsilon' * \mu'')^2 + (\mu' * \varepsilon'')^2 + (\varepsilon' * \mu')^2]^{1/2} \}^{1/2} \quad (1)$$

where λ_o is the wavelength in free space.

Figure 1 displays dependence of attenuation on frequency of the prepared hexaferrite composition x=0.0.

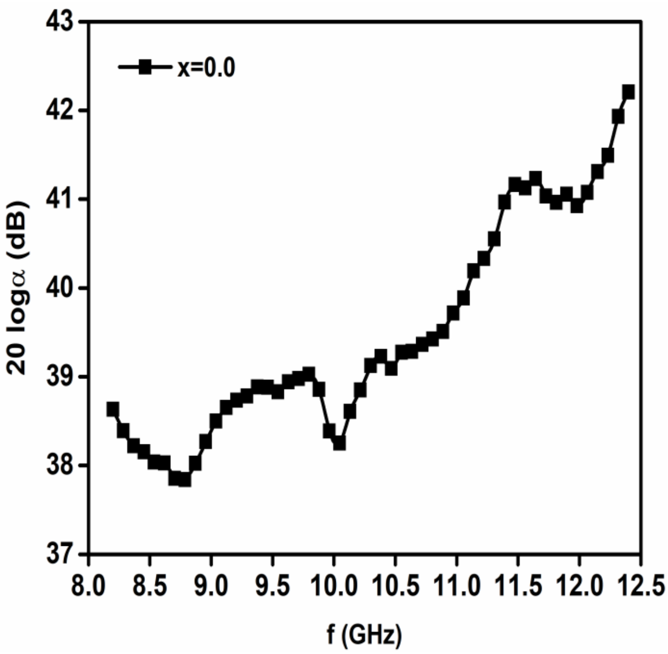

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Figure 1. Dependence of Attenuation (α) on frequency in x=0.0

The decrease in attenuation has been observed in the lower part of the frequency region from 8.0 GHz to 9.0 GHz. Undoped composition displays non linear increase in attenuation with increase in frequency.

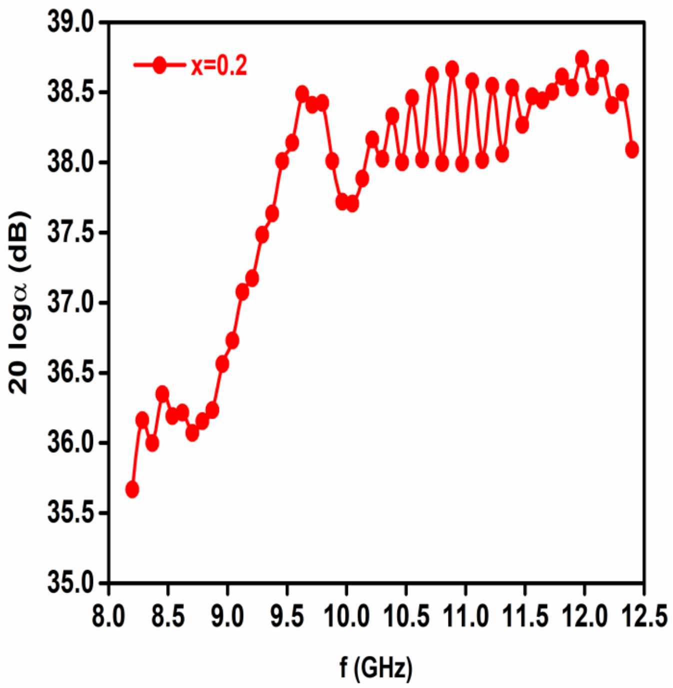

Figure 2. Figure 1. Dependence of Attenuation (α) variation with frequency in x=0.2

Figure 2 exhibits abrupt increase in attenuation from 9.0 GHz to 9.5 GHz in x=0.2. The maximum value of 38.73 dB has been reported at 11.98 GHz. The substitution of Co^{2+} and Cr^{3+} causes increase in attenuation. Number of maximum and minimum peaks are observed in the lower part of the frequency region.

Figure 3 depicts variation of attenuation with frequency for substitution of Co-Cr in M-type Ba-Sr (x=0.4) ferrite. This composition shows linear variation of attenuation with frequency except at 10 GHz and in the higher region where attenuation seems to be constant with frequency.

Attenuation increases linearly with frequency in the lower and middle region of frequency as depicted in figure 4 for the composition x=0.6 and reaches maximal value 43.82 dB at 11.56 GHz.

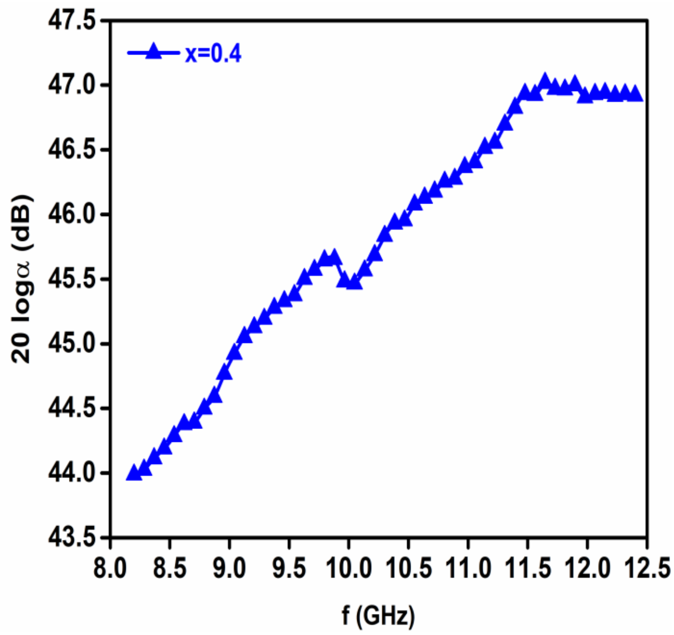

Figure 3. Dependence of Attenuation (α) variation with frequency in x=0.4

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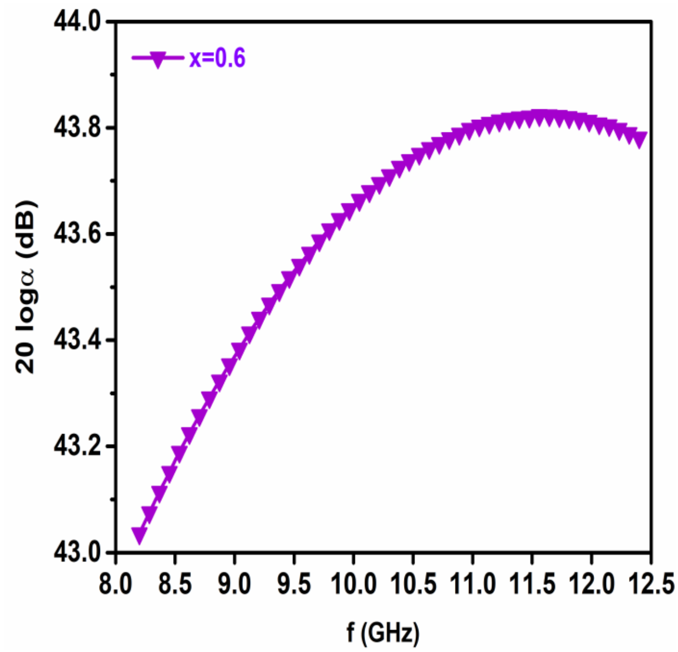

Figure 4. Dependence of Attenuation (α) on frequency in x=0.6

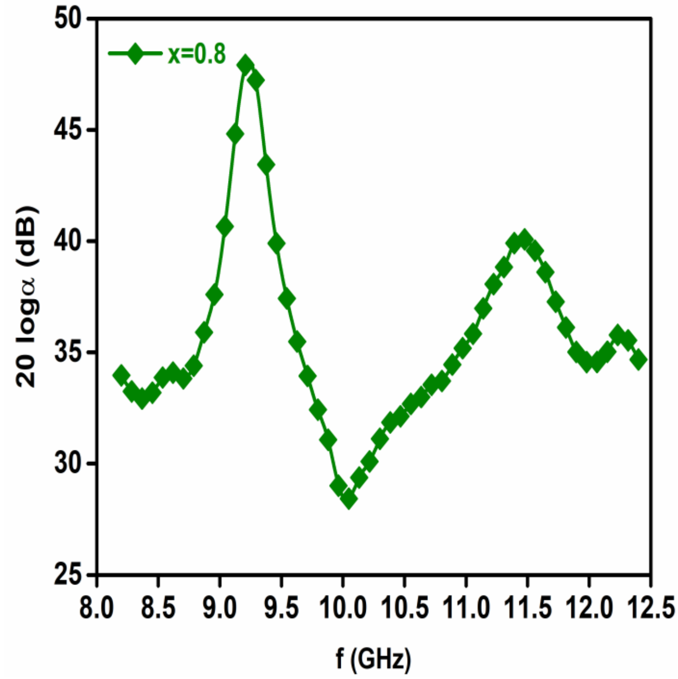

Figure 5. Dependence of Attenuation (α) on frequency in x=0.8

The highest value of α (47.91 dB) has been observed for x=0.8 at 9.208 GHz as shown in figure 5. There is an observation of two peaks in x=0.8 in low as well as high frequency region: 47.91 dB at 9.208 GHz and 40.08 dB at 11.476 GHz. while lowest value of 3.11dB at 10.132 GHz is obtained in the composition x=1.0.

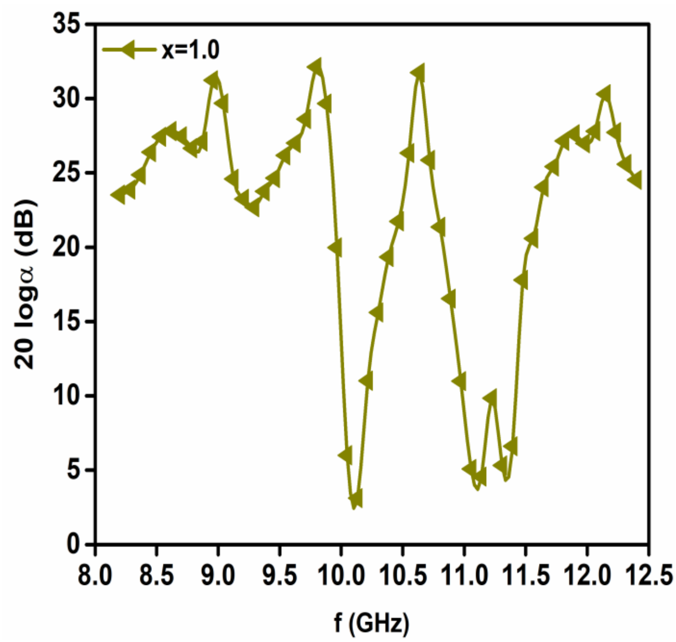

Figure 6. Figure 1. Dependence of Attenuation (α) on frequency in x=1.0

Figure 6 represents α versus frequency for the composition $Ba_{0.5}Sr_{0.5}Co_xCr_xFe_{(12-2x)}O_{19}$ it can be seen from the graph that the values of α varies non-linearly with frequency almost throughout the whole frequency range for the sample x=1.0. It is evident from the table 1 that attenuation increases with substitution from x=0.6 to 0.8, while the decreasing trend is seen from x=0.4 to 0.6. The highest value of attenuation (47.91) is recorded in the composition x=0.8.

Table 1 The maximum value of attenuation for the prepared hexaferrite

Composition	20logα(dB) Maximum	Frequency (GHz)
x=0.0	42.20	12.40
x=0.2	38.73	11.98
x=0.4	47.01	11.64
x=0.6	43.82	11.56
x=0.8	47.91	9.208
x=1.0	32.10	9.796

CONCLUSIONS

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Microwave attenuation is increased with substitution of Co-Cr in Ba-Sr hexaferrite. The maximum increase in attenuation has been noted in x=0.8 at 9.208 GHz. Therefore, the prepared composition can be useful for suppression of unwanted microwave signal.

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