Investigation of microwave characteristics of Ca-Co-Ti ferrite for electromagnetic applications

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In this investigation, we are reporting microwave characterization of M-type $CaCo_xTi_xFe_{(12-2x)}O_{19}$ ferrite for different electromagnetic applications using Absorber Testing Device (ATD) [1] method.

Compositions x=0.2, 0.3, 0.4, 0.6 and 0.7 exhibit large reflection loss from middle to high frequency region (10.6-12 GHz) as shown in figure 1. Composition x=0.6 shows reflection loss of -16.2 dB and -15.0 dB at 11.90 and 10.86 GHz, while x=0.1 and 0.3 exhibit -11.0 dB at 11.65 and 10.64 GHz. Composition x=0.6 displays maximum absorbed power of 97.6 % (Table 1) at 11.90 GHz and can be used as microwave absorber. Compositions x= 0.5 and 0.6 owe maximum transmitted power of 99.9 and 99.3% at 10.24 GHz (table 1) and can be used for lossless transmission. Compositions x=0.1 and 0.2 carry with maximum reflected power of 99.7 and 99.1 % at 11.15 GHz, indicating their possible use as electromagnetic shield. Compositions x= 0.3, 0.6 and 0.7 satisfies the criterion for maximum microwave absorption as shown in table 2; their thickness is equal to $m\lambda_m/4$, where m is integer and λ_m material wavelength. Composition x=0.6 has potential for microwave absorber as well as lossless transmission.

Skin depth non-linearly decreases with frequency and substitution (Figure 2) and is much less in x=0.7 (Inset in Figure 2) than other compositions.

Reference:

1. M.R. Meshram, N.K. Agrawal, B. Sinha, P.S. Misra. Characterization of M-type barium hexagonal ferrite-based wide band microwave absorber. J. Magn. Magn. Mater. 271 (2004) 207-214.

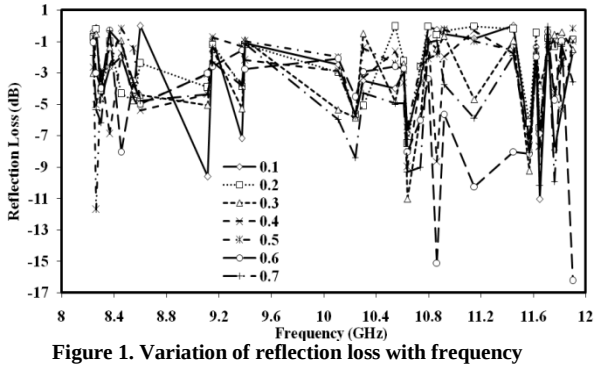

Figure 1. Variation of reflection loss with frequency and substitution in $CaCo_xTi_xFe_{(12-2x)}O_{19}$ ferrite

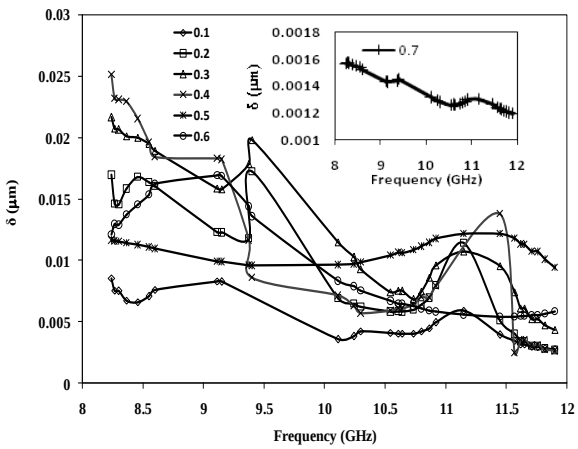

Figure 2. Variation of penetration depth with frequency and substitution in $CaCo_xTi_xFe_{(12-2x)}O_{19}$ ferrite

x	$P_{aborbed\ max.}$ (%) GHz)	$P_{reflected\ max.}$ (%) (GHz)	$T_{ransmitted\ max.}$ (%) (GHz)
0.1	92.1-11.65	99.7-11.15	91.8-9.40
0.2	82.2-10.64	99.1-11.15	98.8- 10.73
0.3	92.1-10.64	91.1-11.82	89.6-10.80
0.4	87.3-10.64	92.7-11.15	96.8-10.30
0.5	93.2-8.27	96.2-8.45	99.9-10.24
0.6	97.6-11.9	93.8-8.37	99.3-10.24
0.7	90.3-11.65	97.6-11.71	92.5-9.115

Table 1. Variation of maximum absorbed, reflected and transmitted power with frequency and substitution in $CaCo_xTi_xFe_{(12-2x)}O_{19}$ ferrite

x	Frequency (GHz)	$m\lambda_m/4$ (mm)	Matching Thickness (t)(mm)
0.3	10.64	2.1	2.0
0.6	10.865	4.5	4.5
0.6	11.15	4.4	4.5
0.7	11.65	4.8	4.9

Table 2. Matching thickness criterion in different compositions of $CaCo_xTi_xFe_{(12-2x)}O_{19}$ ferrite