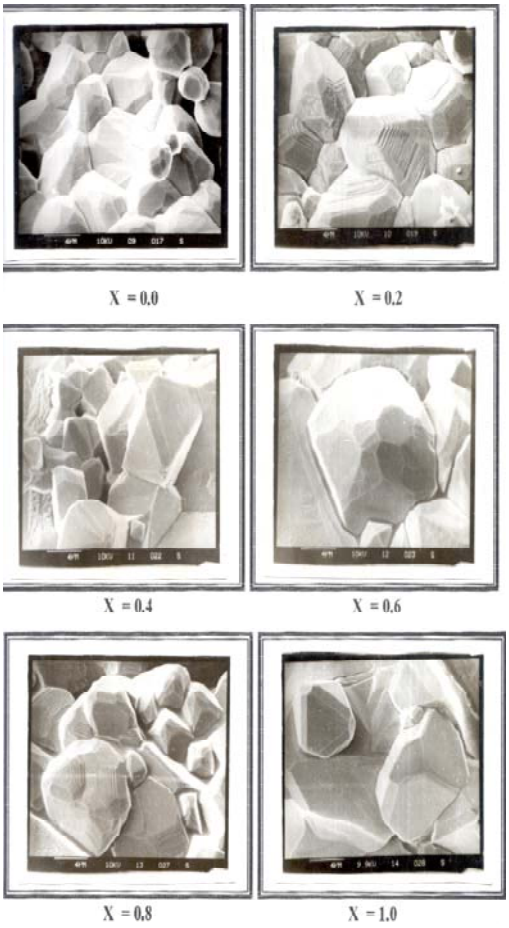

Figure 2: SEM of $Cd_XMg_{1-X}Fe_2O_4$ Ferrite System

The saturation magnetization per formula unit in the Bohr Magneton (n_B) are calculated and presented in table 2. However $MgFe_2O_4$ is almost inverse spinel [15] ,Cu^{2+},Co^{2+} Cd^{2+} preferentially occupies tetrahedral (A) site [16-18]. The Cation distribution in all the ferrites is estimated and presented in the table 2. From figure 3, the n_B variation with Cd^{2+} content evidently suggest the existence of canted spins in Mg-Cd ferrite which is in accordance with the previous report [19, 20]. Y-K angles have been calculated from formula, $n_B = M_B \cos\alpha_{YK} - M_A$ discussed elsewhere [21] and presented in table2. Niessen [22] non co-linear model was applied to calculate resultant on B sub-lattice. B sub-lattice splits into two sub-lattice B_1 and B_2 having magnetic moments and making an angle α_{YK} with their resultant (2 α_{YK} being the angle between the moments on B_1 and B_2). Resultant on B sub-lattice is calculated as,

$$B = \sqrt{[B_1^2 + B_2^2 + 2\, B_1\, B_2 \cos(\alpha_{YK})]}$$

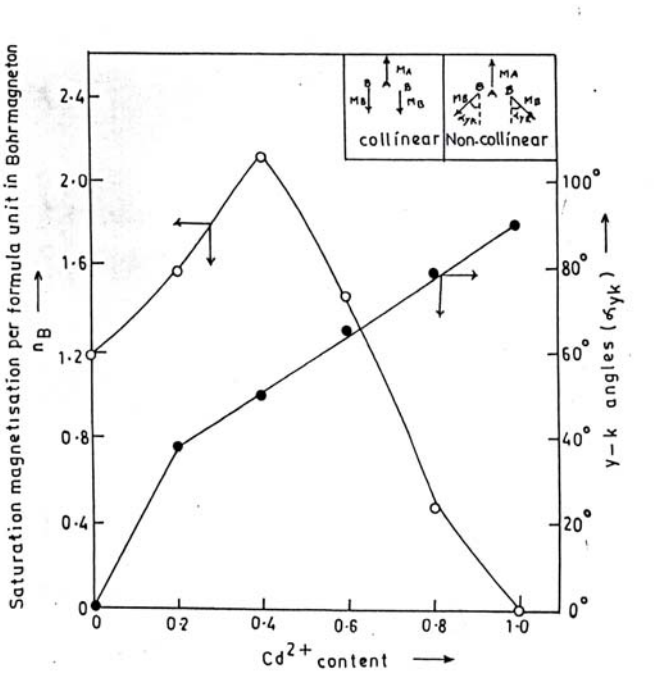

Fig. 3 Dependence of saturation magnetisation per formula unit in Bohr magneton (n_B) with Cd^{2+} content in Mg Cd Ferrite system.

IR absorption spectra show two distinct absorption bands υ_1 at 585cm^{-1} and υ_2 at 420cm^{-1} for $MgFe_2O_4$. This result closely agrees with previous report [23]. A close inspection of fig.4 shows that the absorption band υ_1 is shifted towards lower frequency side & υ_2 becomes broad. The broadening of υ_2 band is found to increase with increase of Cd^{2+} contents up to X= 0.4, while a third band υ_3 in the frequency range 335 cm^{-1} to 380 cm^{-1}, well separated from υ_2 band is clearly observed for $X \geq 0.6$. Replacements of Fe^{3+} by Cd^{2+} on tetrahedral site gives rise the sifting of υ_1 band towards lower frequency side in accordance with theoretical prediction [24]. Reddy et al [25] have reported the shifting of the band towards higher frequency side due to replacements of Mn^{2+} by lighter weight Mg^{2+}. In our case as the Cd^{2+} ion is higher in weight than Fe^{3+} ion, therefore a shift toward lower frequency side could be expected and the results in good agreement. Braber et al [26] have been reported the splitting of band near 700cm^{-1} in $Mn_XFe_{3-X}O_4$ ferrites. Naik [27] and Sagare [28] have observed the splitting around 600cm^{-1} in Li-Cu and Li-Cd ferrites respectively. Dallal et al [29] in1990 have Predicted that shoulder splitting could be observed due to presence of John-Teller ion. V.R.K. Murty et al [30] have reported υ_3 band in Ni-Zn ferrite and variation of band position was ascribed to change in Fe-O bond distance in two crystal lattices. Josyulu et al [31] have reported υ_3 band in Co-Zn ferrites and from intensity variation it was assigned due to divalent metal oxygen complex. K.V.S. Badarinath has observed the third band very close to υ_2 in Al^{3+} substitute $MgFe_2O_4$ ferrite and assigned due to trivalent octahedral substitution. Increase in intensity was reported due to increasing Al^{3+} content in $MgAl_{2X}$ Fe_{2-2X} O_4 ferrite Kunal Modi et al [32] reported the existence of local canted spins in Al^{3+} substituted magnesium ferrite. It has been noticed by Tarate [33] that, the nature of intrinsic vibrations of tetrahedral group and

octahedral sites and to smaller extent on the tetrahedral voids in the spinal structure. The addition of Cd^{2+} ions in the sample up to X = 0.4 increases the Y – K angles so also the broadening of the υ_2 band. However when X > 0.4 with increasing angle (α_{Yk}) and υ_3 band as separate identity in close vicinity of the υ_2 band.

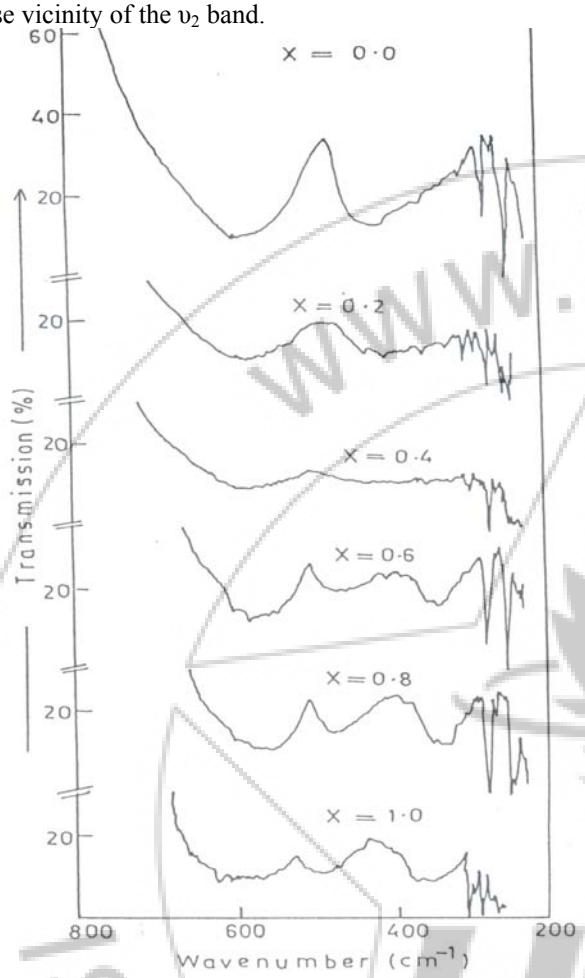

Figure 4: IR Spectrum of $Cd_xMg_{1-x}Fe_2O_4$ ferrite system

4. Conclusions

Third fundamental active mode of vibrations υ3 band observed in Mg-Cd ferrite is assigned due to canted spins where Y-K three Sub-lattice model Predominating. Absent of υ4 band suggests the lattice vibrations under experimental conditions are insignificant.

5. Acknowledgement

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6. Future Scope

Micro-structure of ferrites depends up on preparation technique. There is a scope to reduce the particle size by adopting a preparation technique like wet chemical precipitation method, sol-gel method etc and see the interesting further results for electrical and magnetic properties.

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Author Profile

B. R. Karche received the B. Sc and M. Sc. in Physics from Shivaji University, Kolhapur in 1981 and 1983, respectively. He is an Associate Professor and Head Department of Physics at Shankarrao Mohite Mahavidyalaya, Akluj in Maharashtra (India) since 1983. He is B O S Chairman of Physics, Faculty member of Science, Academic Council member and Management Council member of Solapur University since 2010. He has published ten research papers and presented thirteen research papers in various International and National seminar and conferences. His current interest of research is ferrite thin films for gas sensing applications.

Table 1: Structural and IR data of $Cd_XMg_{1-X}Fe_2O_4$ mixed ferrites

Cadmium Content (x)	Lattice Constant a A^0	X-ray Density D_X gm/cm^3	Average Grain size D µm.	Fundamental Active Mode Of Vibrations		
				υ_1 cm^{-1}	υ_2 cm^{-1}	υ_3 cm^{-1}
0.0	8.372	4.527	3.98	585	420	---
0.2	8.430	4.825	4.00	580	410	---
0.4	8.512	5.066	4.38	575	410	---
0.6	8.560	5.355	5.23	570	480	350
0.8	8.618	5.613	6.22	565	482	350
1.0	8.682	5.847	9.62	595	495	350

Table 2: Cation Distribution and magnetization data $Cd_XMg_{1-X}Fe_2O_4$ Ferrite System

Cd Cont. (x)	Cation Distribution	Magnetisa-tion σ emu/gm	M_s (Gauss)	n_B Bohr Magneton
0.0	$Cd_0Mg_{0.1183}Fe_{0.8817})^A [Mg_{0.8817}Fe_{1.1183}]^B O_4$	33.01	112.8	1.1425
0.2	$Cd_2Mg_{0.0946}Fe_{0.7054})^A [Mg_{0.7054}Fe_{1.2946}]^B O_4$	40.54	149.5	1.5772
0.4	$Cd_4Mg_{0.0710}Fe_{0.5290})^A [Mg_{0.5290}Fe_{1.4210}]^B O_4$	50.12	198.8	2.1118
0.6	$Cd_6Mg_{0.0473}Fe_{0.3527})^A [Mg_{0.3527}Fe_{1.6763}]^B O_4$	32.68	164.2	1.4801
0.8	$Cd_8Mg_{0.0237}Fe_{0.1763})^A [Mg_{0.1763}Fe_{1.8237}]^B O_4$	9.80	51.2	0.4749
1.0	$Cd_1Mg_{0.0000}Fe_{0.0000})^A [Mg_{0.0000}Fe_{2.0000}]^B O_4$	0.00	0.00	0.0000