THE POSIBILITY OF SUPERPARAMAGNETIC CHARACTER IN NANOMAGNETIC STRUCTURE OF Fe_XCo_{1-X}

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Even though much intrest, and extensive researches [1, 2] about controlling the average size distribution, in the clinical magnetic nanoparticles have been directed to iron oxides, but;
1) its low saturation of magnetization and hence the low magnetic moment per unit volume of S.P.I.O. (Super Paramagnetizatic Iron-Oxide) nanoparticle is a problem in spite of its super paramagnetic character[3].
2) some times negative contrusts extends beyond their immediate surroundings and other related phenomena in MRI contrast agents [4].
In spite of the limited value of supperparamagnetic effect and chemical stability, biological compatibility of Fe_3O_4 and γ-Fe_2O_3 with the pure transition metals (Fe , Co) or metallic alloys or compounds of FeCo, the metal nanoparticles of which tend to have a large magnetic moment as well as high saturation magnetization effect, are suggested. But the availability of a feasible lifetime and relaxation time of these materials[5], could be still a challenge in order to consider the limit of field-induced magnetization reversal of Fe-Co alloys, which exist in the α or bcc-based phase and have soft ferromagnetic character with large saturation inductions (about 15 percent greater than Fe) [4]. The following investigations should be considered in order to reach to the goal of the biocompatible nano structure, while a key issue of fundamental research in nanostructure materials is to understand the base of formation of nanoparticles for which the defect, structure disorder and the grain growth (that are thermodynamically unstable parameters) are the basic affects;
i) The stability of chemical and crystal structure of Fe-Co at some values of x on Fe_xCo_{1-x} during the formation of alloys or intermetallic phases, whose magnetic structure are different, as a rule changes the structure, bond type and bond strength as well as the coordination. The investigation is carried out by SEM and x-ray spectroscopy.
ii) The effect of annealing process is considered in each case where, the structural defect due to the large deviations of atomic positions as well as the grain boundaries are the main parameters of the nanoparticle size effects.
iii) The size-effect and size distribution of Fe_xCo_{1-x} are also studied. The competition of both the crystal field effect and exchange interaction which are the main controlling factors for the magnetic moment saturation were determined and hence,
iv) The hysteresis loop of the selected samples is considered by VSM.
As the atomic-electronic structure can be the main cause of the above suggested characters, specially the stability of crystal structure hence the systematic variation of pressure, compressibility of the pure 3d-elements, the functional of internal energy and the chemical pressure of K_f are studied (Fig.1 a, b, Fig. 2 a, b). The manifested deviation in figs 1 and 2 can be due to the range of fluctuation of “s-d” electron or even “s-d” hybridization, where the reconstructive crystal structure can be formed. The cause is manifested by the density of d-electrons at the Fermi surface (Table 1) on which the density of state of degenerated symmetry T_{2g} and e_g plays an important role in transition metals. However in the case of equi-atomic Fe_xCo_{1-x}, inter atomic exchange interactions are also calculated to investigate the effects of "H_c" and "M_r" functions on increasing of the Co concentration (Fig. 3a, b). The hysteresis loops of two selected samples are still far away from the biocompatible-interest.

Refrences:

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[3] Paula Gould nanotoday Vol .1 No4 (2006) 34
[4] S.I.Deniso,T.V.Lyutyy,Haggi,Physical Review Letter 97 (2006) 227202-1
[5] J.M.Maclaran,T.C.Schulthess, et.al J.Applied Physics Vol.85,No8, 4833-4835

Table and Figures:

element	Ti	V	Cr	Mn	Fe	Co	Ni
n_d(au)	21.63	20.95	9.25	21.23	41.63	27.35	55.24

Table 1: The density of d-electron at the Fermi surface

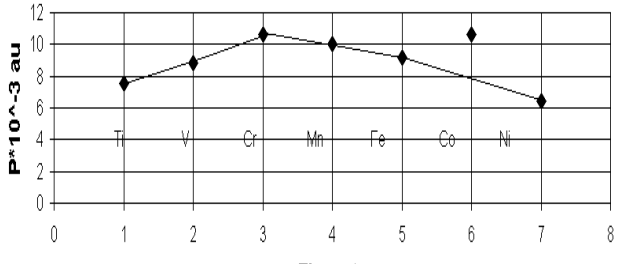

Fig.1 (a) The variation of chemical pressure of 3-d element

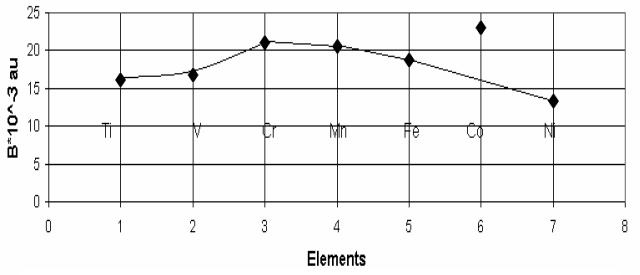

Fig.1 (b) The variation of compressibility whit3-d element

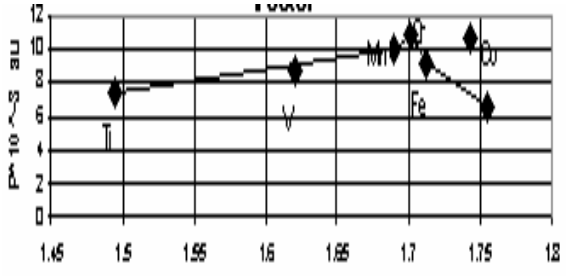

Fig.2 (a) The variation of presuer vs K_f

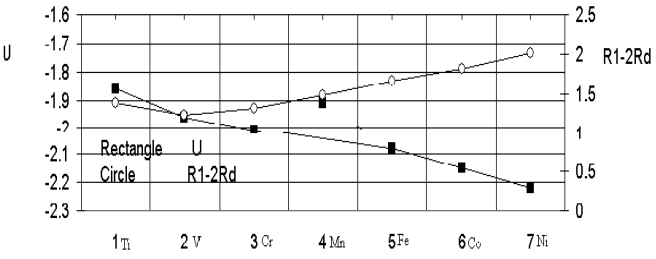

Fig.2 (b) The variation of internal energy and the free accessible space vs 3-d element

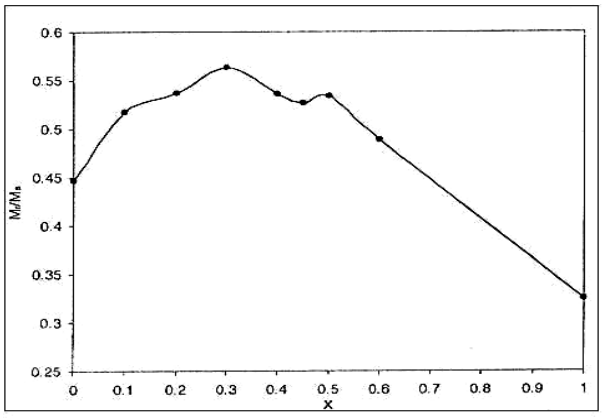

Fig.4 (a) Variation of Mr/Ms vs of Co% for the Fe_xCo_{1-x}

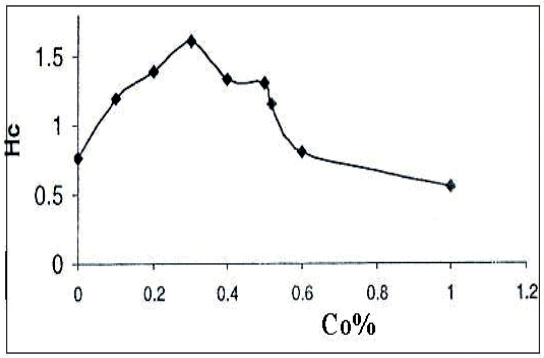

Fig.4 (b) Variation of coersivity whit Co%