WEAK FERROMAGNETISM

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ABSTRACT

The magneto optic properties of FeBO_3are determined by the limits in the dielectric absorption tensor, which depend on the ferro and antiferromagnetism vectors. A classic example of the effect of crystal magnetic symmetry on the formation of a weak ferromagnetic moment is hematite α= 〖Fe〗_2 O_3, which has a rhombohedral elementary cell with four iron atoms. Hence the term "parasitic ferromegnetism", a term still found in some foreign literature.

KEYWORDS: *Antiferromagnetic, Hematite, Spinorientation, Crystal, Ferromagnetic Moment*

INTRODUCTION

In many antiferromagnets, the properties of the crystal structure are such that the sub-lattice atoms with opposite directions of magnetization are in less crystallographic states, so they are affected by different anisotropic forces. This (if crystal symmetry allows) can lead to non-collenear sub-lattice magnetization, their exact mutual compensation is violated, and in total the nominal $10^{-2} \div 10^{-5}$a small spontaneous magnetization occurs. Noncolenear anisotropy may be associated with both indirect exchange interactions and with single-ion anisotropy. The phenomenon of such a small spontaneous magnetization is called weak ferromagnetism, and the substances observed in this phenomenon are called weak ferromagnets. **[1-8]**

The presence of insignificant spontaneous magnetization in hematite ($\alpha - Fe_2O_3$) and a number of 3d-metal salts has long been known, and many researchers have suggested the presence of ferromagnetic (compound, foreign) primes in samples. Hence the term "parasitic ferromegnetism", a term still found in some foreign literature. During the preparation of more pure crystals, it became clear that the presence of spontaneous magnetization was a property of the crystals themselves, and that A.S. Borovik-Romanov had suggested that it was due to the noncollinearity of the bottom of the magnetic grille. The theoretical basis of this idea was given by I.E. Dzolyashinsky **[9, 10,11,12].**

In the example of rhombohedral carbonates $MnCO_3$ and $CoCO_3$belonging to the spatial group $D_{3d}^6(R3c)$and having the following elements of symmetry in the paramagnetic state, we see the formation of weak ferromagnetism: $2C_3$, $3U_2$, I, $2S_6$, $3\sigma_d$, R.

$2C_3$- third-order axes, parallel to [111];

$3U_2$- second-order axes, perpendicular to [111];

I - Inversion;

S_6 – is the axis of rotation of the sixth order mirror;

σ_d – is the translational sliding plane along the [111] axis and perpendicular to the U_2 axis.

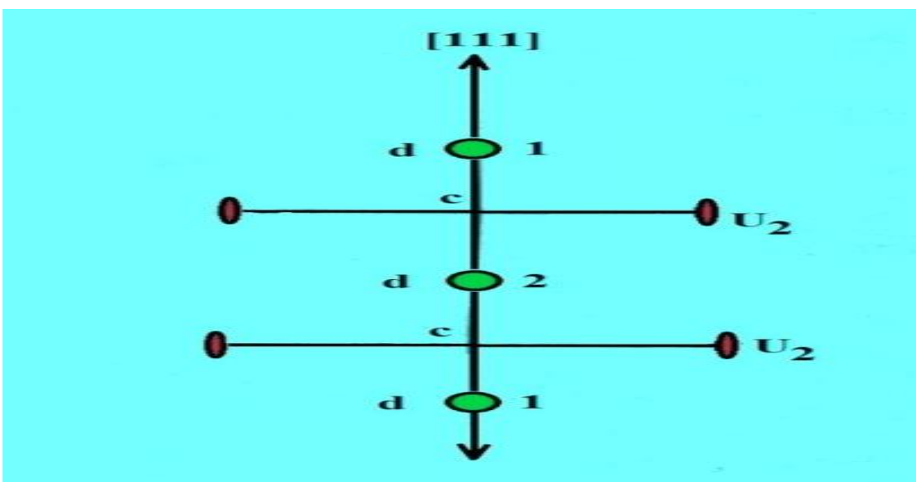
Figure 2.2.1 shows the location of magnetic ions and some elements of symmetry in the structure of carbonates. The magnetic properties of the carbonates are well represented by the two magnetic grid substrates, and the magnetic element cell is compatible with the crystal chemistry.

Thus, the magnetic atoms 1 and 2 (Figure 2.2.1) correspond to a single elementary cell but under different magnetic grids. Some of the elements of symmetry listed are missing.

C_3: $1\rightarrow1$, $2\rightarrow2$, U_2: $1\rightleftarrows2$; S_6va$I$: $1\rightarrow1$, $2\rightarrow2$; σ_d: $1\rightleftarrows2$.

There are three possible types of magnetic structures (Figure 2.2.2).

In structure A, the magnetic moments under the grid are oriented along the axis [111], in structure B the magnitude σ_d lies in the plane of symmetry, and in structure C the direction σ_d is oriented along the axis. $FeCO_3$ has a structure A, while $MnCO_3$ and $CoCO_3$ have a structure B.



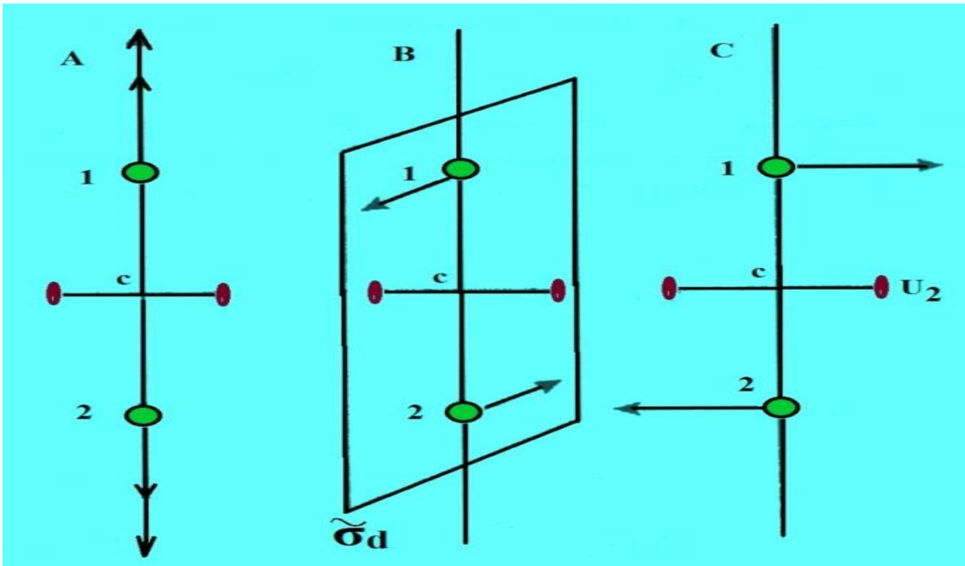
(Figure 2.2.1)

Figure 2.2.1.Location of magnetic (1, 2) ions along the axis in the crystals of carbonates $MnCO_3$, $FeCO_3$ and $CoCO_3$[111].

c is the point of intersection of the axis of symmetry $U_2$with the axis c- [111];

The points of intersection of the return planes for the d- [111] axis and the S_6 axis.

Structure A has all the elements of spatial crystallographic symmetry except R. Well, in such a magnetic structure [111], the resultant magnetic moment$\vec{m} = \vec{m}_\perp + \vec{m}_{||}$, which is parallel and perpendicular to the axis, is $\vec{m}_{||}$and $\vec{m}_{\perp}$, respectively. 'ladi. $\vec{m}$is invariant with respect to the C_3 axis, and $\vec{m}_A$is not invariant, so m can be invariant with respect to this symmetry operation only when$\vec{m} = 0$. Thus, there can be no weak ferromagnetism in structure A, in fact, $FeCO_3$ does not have a weak magnetic moment.



(Figure 2.2.2)

Figure 2.2.2. The 3d-metal carbonates $FeCO_3$, $MnCO_3$ and $CoCO_3$are the three possible orientations of the magnetization of the magnetic substrate.

In structure B, the magnetic moments are in the $\sigma_d$plane (perpendicular to the plane of Figure 2.2.2) and the symmetry elements are I, U_2, $\sigma_d$which allows the magnetic moments of the 1- and 2-ions to rotate out of the σ_d plane against each other. the moment U_2 becomes m $\neq 0$ along the axis (see Figure 2.2.3). Indeed, $MnCO_3$ and $CoCO_3$compounds are weak ferromagnets. A classic example of the effect of crystal magnetic symmetry on the formation of a weak ferromagnetic moment is hematite α=Fe_2O_3, which has a rhombohedral elementary cell with four iron atoms. At a temperature of 250 K, a spin-oriented spatial transition in hematite may be appropriate, i.e., the magnetic structure changes. At a temperature T <250 K, the magnetic moments of the iron ion lie parallel to the axis of the crystal [111], and at a temperature T> 250 K, it lies in the base plane near the Neel point (950 K). In the first case, weak ferromagnetism is prohibited, while in the second case, the magnetic structure allows it. In fact, small spontaneous magnetization is observed only in the temperature range of 250K ÷ 950K. [**13-24]**

CONCLUSION

The magneto optic properties of $FeBO_3$ are determined by the limits in the dielectric absorption tensor, which depend on the vectors of ferro and antiferromagnetism, in which the magnetoooptic properties of the crystalit is sufficient to consider only the dielectric absorption tensor component, which represents the cross section of the optical index of the plane perpendicular to the C_3 axis, to analyze its properties. Studies have shown that the existing oriented spatial transitions theory $Tb_{0,2}Y_{2,8}Fe_5O_{12}$ cannot represent the multidimensional temperature-dependent evolution observed in the domain structure of the sample, and the crystallographic mechanical stress of the sample is significantly different from the spin reorientation. 'It's a mystery. **[25-28]**

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