New Magneto-Electric Ferrite Materials

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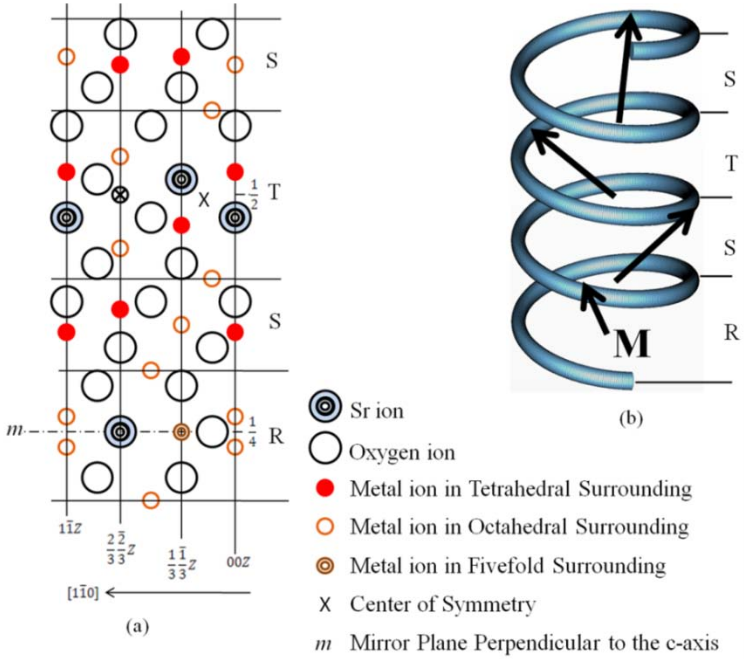
These new ME materials which are operational at room temperature are identified as hexaferrites of the M,Y and Z-types. The unique feature of these hexaferrites is that the unit cell consists of spinel blocks stacked on top of each other. These spinel blocks are referred to as S (TMFe2O4), R (BaFe4O7) and T (2BaFe4O7) blocks, where TM implies a transition metal ion and Ba substitution may be replaced by Sr or Pb ions. The chemical formula of a typical M-type hexaferrite is BaFe12O19, for Y-type as Ba2Fe12TM2O22 and Z-type as Ba3Fe24TM2O41.The lattice constants along the c-axis are, respectively, 22, 43 and 52A.Clearly,the Z-type hexaferrite contains the largest unit cell along the c-axis and, therefore, the most spinel blocks (SRSTS*R*S*T*), where the * imply 120,240 and 180 degrees rotation with respect to the unmarked block. As a general experimental rule the more stacking of the spinel blocks is required, the more difficult it is to prepare the hexaferrite in question. For example, the Z-Type require the most stacking of the above set of spinel blocks and indeed it is the most difficult to prepare. The mechanism that gives rise to magnetoelectricity(ME) is due to local distortions or strains induced by replacing Ba with a smaller Sr ion. The local distortion ,located in the T block for Z-type and R block in the M-type hexaferrites, implies that the bonding angle in Fe-O-Fe combination near the Sr substitution is changed from 116 degrees (with Ba) to 123 degrees (with Sr). This has great ramifications in terms of the superexchange interaction between the two Fe ions and spins in the S block and spins in the R or T block yielding a spin spiral cone configuration described by the Dzyaloshinski-Moriya interaction model. Thus, any change in the cone angle of the spin spiral configuration is reflected in a change in the local strain and viceversa. The change in the strain manifests itself as a change in electric polarization, since these hexaferrites are also electrostrictive. Thus, the application of a magnetic field H changes the cone angle of the spin spiral configuration to induce a change in the local strain and, therefore, the induction of an internal electric field or polarization.



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