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Magnetodielectric materials for VHF antenna devices tunable by a low DC magnetic field

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The implementation of magnetodielectric materials (MDM) specifically fabricated for integration into antenna devices operating at VHF band (30-300MHz) is presented. Samples of NiZnCoCu spinel ferrites, with a toroidal geometry, are fabricated. Their permeability, measured along the orthoradial direction, shows a noticeable variation when the symmetry of the driving field lines, of intensity lower than 10 Oe, is consistent with that of the magnetic domain structure. The MDM is used to load an antenna, and leads to a miniaturization factor of 20 % and a potential of frequency agility of 6 % in VHF band close to 70 MHz.

Keywords: magnetodielectrics, permeability, high frequency, tunability, antenna

1. Introduction

The problem of the tunability of antenna devices controlled by the application of a continuous magnetic field is complicated by the value of the field strength required (>4000 Oe) for their implementation, due to the importance of the shape demagnetizing effects [1]. To overcome this effect, we propose to use a toroidal material, the domain walls adopting an approximately orthoradial symmetry. The permeability can then be easily modified by a magnetic field of the same symmetry, without the appearance of demagnetizing shape effects. Our main objective is to vary the permeability value of the MDM by using a DC magnetic field <10 Oe, in order to achieve an antenna tunable by currents of <9A.

2. Experiments and results

We used polycrystalline NiZnCoCu ferrites prepared by the Lab-STICC. They were obtained from powders synthesized by coprecipitation [2]. The toroidal-shaped samples were obtained by uniaxial pressing, before to be subjected to a suitable heat treatment. The permeability of the samples was first measured at $f=10\text{kHz}$ by the transformer method. The common orthoradial symmetry of the polarisation field \vec{H} (created by a control current I) and the microwave field \vec{h} respects the symmetry of the sample, and therefore that of the magnetic walls, thus avoiding the creation of demagnetising effects other than those related to grain boundaries and porosity. Results got for samples (differing in composition) S2 and S6 show permeability variations close to 70 and 30, respectively, for a static field varying between 0A/m and 660 A/m (i.e. 8Oe, corresponding to a maximum current of 9A). Measurements of the variation of the

permeability with frequency up to 3GHz, and under the action of a DC magnetic field controllable by a current limited to 5A, was also performed, that confirm the existence of a variation of permeability in the VHF band. A prototype IFA antenna has been developed by CEA-LETI [3]. In addition to a miniaturisation of the antenna by 20%, a frequency agility of the antenna of 6%, at $f=72\text{MHz}$, for a drive current (5A) producing an average field strength of 1.7 Oe (i.e. 120 A/m) at the toroids is obtained.

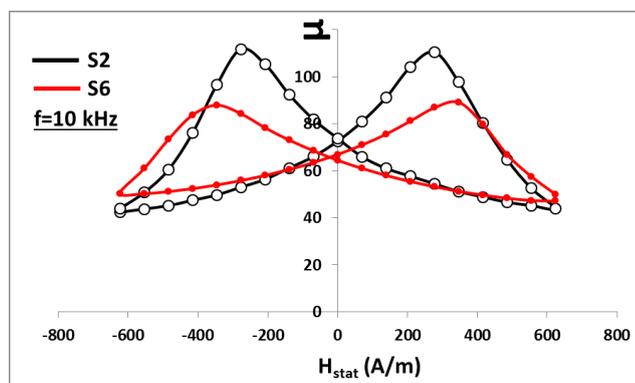


Figure 1 : Permeability dynamics of MDM

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