Dielectric substrates anisotropy Effects on the characteristics of Microstrip structures

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In this paper, I will focus on an overview study of the dielectric substrates anisotropy effects on the characteristics of microstrip transmission lines and other passive circuits belonging to this family of microwave components. All these microwave components consist of very thin miniature metallic patterns printed on the upper surface of a dielectric layer or multilayer substrate with the opposite surface completely covered by a very thin metallic layer representing the ground plane. The metallic patterns can have several shapes according to the desired microwave component or characteristics. Hence, this basic structure can fulfil several functions such as transmission lines, resonators, filters and antennas.

The dielectric layer or multilayer substrate's properties play a key role in defining the overall characteristics of these structures and therefore the performances of the applications they will take part in. One of the most important characteristics of dielectric materials is their anisotropy, which means that, either or both of the electric permittivity and magnetic permeability are represented by tensor magnitudes. The latter case is also referred to as bianisotropy in the specialized literature. This means that both the dielectric electrical and magnetic properties vary with direction. According to these specific properties a shift from the isotropic characteristics can be expected for microstrip structures with bianisotropic substrates. Therefore, for an accurate design of such structures bianisotropic properties should be accounted for in the design model or tools.

Most of the design models of these structures are based on the resolution of Maxwell's equations using the appropriate constitutive equations and boundary conditions. The numerical resolution of the resulting boundary value problem is carried out numerically using any one of the numerical methods such as the method of moments, the method of lines, FDTD, finite elements, etc. Furthermore, these design models can be based either on a quasi-static approach or a full wave approach. The first one is very simple but is limited in frequency while the latter one is more rigorous and more demanding in terms of computer resources.

Numerical results will be given for several illustrative examples including a recently proposed microstrip structure. It is shown that anisotropy effects on microstrip structures are very significant and should be taken into account for an accurate design of these microwave components.