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CAD Cavity Model Analysis of High Tc Superconducting Rectangular Patch Printed on Anisotropic Substrates

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Abstract—**This paper, present the resonant and the radiation characteristics of superconducting rectangular microstrip antenna printed on uniaxailly anisotropic substrate using an electromagnetic approach based on cavity model in conjunction with electromagnetic knowledge. The cavity model combined with London's equations and the Gorter-Casimir two-fluid model has been improved to investigate the resonant characteristics as well as the radiation patterns of high Tc superconducting rectangular microstrip patch in the case where the patch is printed on uniaxially anisotropic substrate materials. The most advantage of our extended model include low computational cost and mathematical simplify. The numerical simulation of this modeling shows excellent agreement with experimental results available in the literature. Finally, radiation patterns of superconducting rectangular patch on anisotropic substrate are also presented.**

Keywords-component; Superconducting microstrip antenna; resonant frequency; radiation patterns; cavity model; Gorter-Casimir two-fluid model; anisotropic substrate.

I. INTRODUCTION

The high-temperature superconductor (HTS) have made possible the design of low-loss, low-dispersion transmission lines, interconnects, microwave filters, and highly efficient antennas [1], due to the much lower surface over corresponding devices fabricated with normal conductors such as gold, silver, or copper [2, 3]. A high-temperature superconducting microstrip antenna can obtain a rather high gain, but suffers from a very narrow bandwidth, but they suffer from the extremely narrow bandwidth, which severely limits their application [2, 3]. Numerous analyses have been carried out to enhancing the bandwidth of high-temperature superconducting microstrip antenna [4-6]. In the past, several researchers have studied the superconducting microstrip antenna printed in layered isotropic dielectric [2, 4-6]. Other researchers have suggested that certain anisotropic dielectric proprieties could be used to enhance the resonant and the radiation characteristics of microstrip antennas [7-9]. The different computation methods for computing the resonant characteristics of microstrip patch printed on anisotropic substrate are available [4-9]. All these efforts produce high accuracy results but they are not suitable for direct synthesis of patch antenna due to their complexity and high computational time [10]. So, the full wave analysis is not well suited for direct synthesis of patch antenna. The computer-aided design (CAD) oriented conformal mapping, transmission line, and cavity model is ideal for design purpose because it involves less mathematical steps and less computational time. It is also easy to implement, provide closed form expressions [10]. In the present work, the cavity model analysis is extended to provide accurate CAD of HTS microstrip antennas (MSA) on anisotropic substrates. Furthermore, some modifications are made to account for fringe fields, dispersion effects, and losses by calculating effective dimensions, and effective relative permittivity, respectively. However, the paper surpluses detailed numerical results both for the resonant frequency, bandwidth, and the radiation characteristics of the antenna. In fact, to the best of the author's knowledge, there is no theoretical report on the effect of both anisotropy in the substrate and the presence of superconducting patch, on the resonant characteristics of rectangular microstrip antenna by using cavity model analysis. These characteristics are firstly presented in this study by using modified cavity model. This paper is organized as follows. In Section II the problem is defined using cavity model analysis, the anisotropy in the substrate and the superconducting films are then explicitly taken into account in the formalism of the problem. In Section III the resonant and radiation characteristics of high-temperature superconducting rectangular microstrip antenna on anisotropic layers are presented, a discussion of the results obtained is also presented. Finally, conclusions remarks are presented in Section IV.

II. SUMMARY OF METHOD OF ANALYSIS

The problem to be solved is illustrated in Fig. 1. The rectangular superconducting patch of thickness t with dimensions (L, W) along the two axes (x, y), respectively, is printed on a grounded dielectric slab of thickness h . The substrate is characterized by the free space permeability μ_0 and a permittivity $\varepsilon_0\, \varepsilon_r$.