J Comput Electron (2015) 14:747–753
DOI 10.1007/s10825-015-0708-y

Hankel transform domain analysis of covered circular microstrip patch printed on an anisotropic dielectric layer

Sami Bedra[1] · **Tarek Fortaki**[2]

Published online: 4 June 2015

Abstract In the present paper, a rigorous full-wave analysis for determining the resonant frequency and half-power bandwidth of covered circular microstrip patch antenna is presented. Green's functions of the structure are determined in Hankel transform domain. Galerkin's is used in the resolution of the electric field integral equation. The TM set modes issued from the cavity model theory are used to expand to unknown current on the patch. For an isotropic substrate, it is demonstrated that the bandwidth decreases with increasing ratio of superstrate-substrate thickness for high permittivity and low thickness of superstrate. Also, we show that the resonant frequency and bandwidth are highly dependent on the permittivity variations along the optical axis. The validity of the results is tested by comparing results with those published in the literature. Also, numerical results for the variation of the resonant frequency and half-power bandwidth of the substrate-superstrate configuration for high order modes, and for several values of substrates thickness are presented.

Keywords Covered circular-disk microstrip antenna · Galerkin approach · Anisotropic substrate

1 Introduction

Microstrip antennas are becoming popular for wireless communication systems since they have low profile, light weight, low cost and integration capability with MMICs [1–3]. Owing to the inherent narrow bandwidth of this type of antenna around their operating resonant frequencies, it is important to develop accurate algorithms for the computation of those resonant frequencies [4–6]. The addition of a superstrate layer over microstrip patch antenna has been reported to allow for the enhancement of the antenna gain and radiation efficiency, effectiveness and polarization of the antenna [1,7,8]. Furthermore, superstrate layers are often used to protect the microstrip antenna from its environment hazards, especially when placed on aircrafts and missiles [4,8,9]. During recent years, great interests have been shown in using microstrip antenna deposited on anisotropic substrate since the substrate anisotropy could have important applications on the operation of microstrip antennas [10–12]. With the increasing complexity of geometry and material property, designing these antennas requires more and more dedicated and sophisticated computer aided-design (CAD) tools to predict the characteristics. The method of moments (MoM) has been proven to be one of the most powerful CAD tools for solving this class of problems. By now, a number of microstrip antennas with anisotropic substrate have been investigated using the MoM based spectral domain analysis method [10–12]. Many works have studied the effect of uniaxial anisotropy on the resonant characteristics of a single-layer circular microstrip antenna in [13–17], where the positive and negative uniaxial anisotropies were considered. On the other hand, the effects of isotropic dielectric superstrate on the resonant frequency and the bandwidth of a circular microstrip patch radiator have been experimentally investigated by Losada et al. [18], and theoretically by Guha et al. [19].

In a previously presented study [20], have shown that circular patch microstrip antenna with properly selected uniaxial substrate is more advantageous than the isotropic one by exhibiting wider bandwidth characteristic with differ-

✉ Sami Bedra
s_bedra@yahoo.fr; bedra_sami@yahoo.fr

[1] Industrial Engineering Department, University of Khenchela, 40004 Khenchela, Algeria

[2] Department of Electronics, University of Batna, 05000 Batna, Algeria