Analysis of Rotationally Symmetric Resonators

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Introduction

Dielectric resonators are important components in modern photonic circuits as they exhibit high Q-factor, high sensitivity and directional emission and can be used in many communication and sensor applications. Three-dimensional analysis of these structures has been undertaken mainly with numerical methods such as Finite Difference Time Domain (FDTD) whilst analytical methods have been applied to simplified two-dimensional models [1]. In this paper we report a combination of Body of Revolution Method (BOR) [2] with the method of analytical Regularization (MAR) [3] for modeling of rotationally symmetric bodies. In the BOR method the azimuthal symmetry of the structure is integrated within the free space Greens's function to give a Modal Green's Function (MGF). This enables reduction of the 3D body to the equivalent 2D one without any loss of accuracy. The MGF function is highly oscillatory and an equivalent series representation of the MGF integral has been reported in [4]. The BOR equations are reduced to the integral equations of the Fredholm type by extracting the frequency dependent part corresponding to a suitable canonical shape [3], in this case perfect sphere.

Results

The BOR-MAR method is initially applied to the analysis of the resonant frequencies of metal spheroidal resonators. In particular modes with high azimuthal order are analysed. The spheroidal resonator with the major axis a=1μm and the minor axis b=0.9μm is considered. Fig.1 compares the resonant frequencies of the spheroidal resonator with those of the perfect sphere for the azimuthal order m=5. It can be seen that the resonance shift of the spheroid modes is not trivial and the additional resonances present can be attributed to TE-TM coupling.

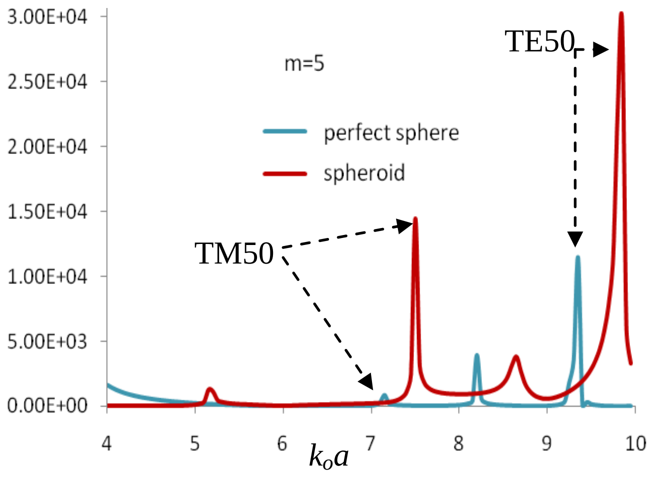

Fig.1.Comparison of resonant frequencies of the perfect sphere and spheroid for m=5

References

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