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Slot Line Excitation of Whispering Gallery Oscillations in Shielded Dielectric Resonators

A. Ya. Kirichenko, A. E. Kogut, V. V. Kutuzov, S. O. Nosatyuk, and V. A. Solodovnik

Usikov Institute of Radiophysics and Electronics of the National Academy of Sciences of Ukraine, Kharkiv, Ukraine

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Abstract—Electrodynamic characteristics of a half-disc shielded dielectric resonator operating in the 8-mm wavelength range have been investigated experimentally. A slot line was proposed for the excitation of whispering gallery modes in such resonator. It has been found out that the proposed excitation technique is effective and allows the high-Q oscillations of higher orders to be excited in a shielded dielectric resonator without additional energy losses. The partial shielding of the resonator in question was proposed for its spectrum rarefaction.

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INTRODUCTION

Open disk and spherical dielectric resonators (DR) with whispering gallery (WG) oscillations feature amply recognized merits in the millimeter wavelength range. The high values of Q-factor close to the values determined by the resonance energy losses in the material of resonator are their main advantage [1, 2].

Along with DR in the form of dielectrical bodies of revolution, a number of microwave devices make use of their halves located on a flat conducting mirror [2, 3]. The latter, in fact, replaces the missing half of disk or sphere and creates the possibility of effective excitation of WG oscillations in case of the local coupling of DR with rectangular waveguide.

However, along with obvious advantages of such resonators, they have the following disadvantages in case of their use in specific instruments and devices.

1. Open type of dielectric resonators is a source of electromagnetic interferences that can be produced by them. In this case, negative effect is produced by both their impact on nearby and unprotected elements of microwave circuits and the inverse influence of external radiation on the formation of selective properties of dielectric resonators.

The main method of controlling such parasite electromagnetic impact implies the use of shielding the dielectric resonance structures. However, as shown in publications on studying the properties of dielectric resonators, the shielding results in a significant oscillation spectrum crowding [4, 5].

Along with WG modes the so-called beam oscillations exist in shielded DR [4]. Their name is justified by the similar notions of geometrical optics. A beam of waves generating these oscillations can be presented in the form of different N-gons inscribed into the resonator circumference. By their nature they are close to WG modes. Their fields are located deeper in the dielectric as compared with the fields of WG modes, while the size of areas of field localization is largely determined by the characteristics of excitation source. In the absence of a metal shield the beam oscillations in DR are not excited due to the lack of compliance with the condition of complete internal reflection of waves on the curvilinear surface of dielectric structure.

As shown in [5], the density of oscillation spectrum of shielded DR can be so significant that at some sections the resonance responses of individual oscillations overlap. From the application viewpoint this implies the possibility of emergence of uncontrolled changes of frequency.

2. The second issue of concern is the WG mode excitation of DR. It is well-known that the most effective technique of exciting WG modes in DR is the use of local coupling elements located in the region of localization of fields of WG oscillations. However, in this case we observe a significant reduction of the DR Q-factor due to high radiation energy losses at the excitation element [6].

In view of the above the major tasks of investigations are as follows: