

Radiation from a Coaxially Fed Annular Slot Surrounded by Corrugations

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Recently, there have been substantial efforts to study beaming light from a subwavelength hole surrounded by surface corrugations associated with the surface plasmon polariton (SPP) resonance theoretically, numerically, or experimentally. Also, beaming from a subwavelength hole surrounded by corrugations in micro/millimeter wave regime due to spoof SPP or SPP-like modes has been investigated numerically or experimentally. The previous studies have considered the plane wave scattering from a subwavelength hole surrounded by corrugations in a conducting plane, but the radiation from a coaxially fed slot surrounded by corrugations has not been presented. Also, the previous theoretical works have considered the only fundamental mode but the full-wave analysis including higher-order modes seems to be lacking. Therefore, it is of interest to rigorously solve the radiation problem of a coaxially fed annular slot surrounded with corrugations. In this work, we shall solve the boundary-value problem of the radiation from a coaxially fed annular slot surrounded with concentric corrugations by using the Hankel transform, eigenfunction expansion, and mode matching method. The radiated fields are represented in a fast convergent series and computed in terms of corrugation geometry to understand the radiation characteristic.

Let us consider a coaxially fed annular slot surrounded with concentric corrugations. We represent the scattered electromagnetic field in terms of continuous and discrete modes in open and closed domains, respectively. The boundary conditions are enforced to obtain a set of simultaneous equations for the unknown modal coefficients. The radiated fields can be represented in a fast-convergent series.

An extensive analysis is performed to illustrate the radiated fields from an annular slot surrounded by corrugations. The effects of the width, depth, periodicity, and number of corrugations on the radiation are discussed. The beaming from an annular slot surrounded with corrugations due to SPP-like modes is observed. Our theoretical formulation is useful to design a coaxially fed annular slot antenna surrounded by corrugations.

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