

A Study on Sub-Wavelength Grating Nonradiative Dielectric Waveguide for Single Mode Transmission

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With the development of wireless communications, study on millimeter-waves and terahertz-waves using on 5G and 6G communications is conducted widely. In these applications, circuit design is a critical factor as well as design. For millimeter waveguide, microstrip line type and coplanar line type monolithic microwave integrated circuit (MMIC) have been considered as platforms. In addition, non-radiative dielectric waveguide (NRD guide) is also expected as a platform for millimeter waveguide that can construct millimeter-wave circuit with small footprint and low loss[1, 2]. NRD guide is a dielectric waveguide sandwiched between parallel conductor plates and achieve nonradiative propagation by selecting the distance of parallel plates to be less than half wavelength of propagation wave. By the way, conventional NRD guides support two nonradiative modes, such as, longitudinal-section electric (LSE_{01}) mode with electric field perpendicular to the conductors, and longitudinal-section magnetic (LSM_{01}) mode with electric field parallel to the conductors. In general, LSM_{01} is used because of its low loss nature compared with LSE_{01} . However, undesired mode coupling occurs at bending and discontinuity part in millimeter-wave circuit, as shown in Fig. 1(a). Therefore, optimal design has to be required even for simple waveguide bend. In order to eliminate these difficulty of circuit design, we propose sub-wavelength grating [3] NRD (SWG-NRD) guide which makes possible to propagate only single mode corresponding to LSM_{01} mode. In SWG-NRD guide, the effective refractive index of the LSE mode can be reduced to make the cutoff frequency of LSE mode higher than that of the LSM mode. Figure 1(b) shows a propagation field in SWG-NRD waveguide bend. LSM_{01} mode in conventional NRD guide transmits via taper waveguide to SWG-NRD waveguide. We can see that any undesired mode coupling does not occurs at bending waveguide.

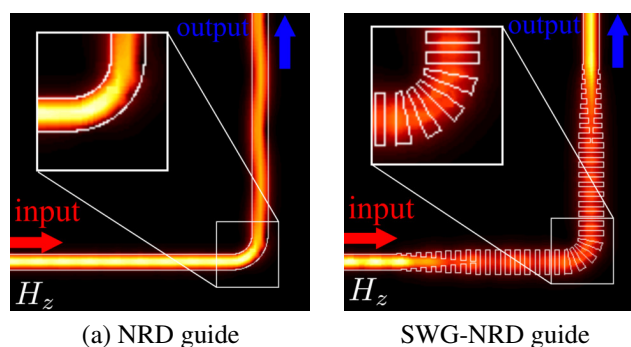


Figure 1. Propagating field in waveguide bend.

References

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