Terahertz plasmonic slab waveguide based on a metal rod array

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1. Introduction

Terahertz (THz) plasmonic devices typically consist of metallic structures with micrometer- or subwavelength-scaled units, and lead to excellent optical properties, such as the field confinement and enhancement [1]. Such unique performances are attractive and considered as the features of novel photonic devices in THz frequency region. However, the confined waveguide field normally results in the strong waveguide attenuation and dispersion [2], consequently hindering the possible applications of THz plasmonic devices. Therefore, engineering the periodic metal structure of a THz plasmonic device to transport THz waves with high field confinement and low loss is urgently requested currently. In this presentation, one THz plasmonic slab waveguide based on a free-standing metal rod array (MRA) is demonstrated, and the waveguide modal field tailored via the MRA parameters is successfully achieved [3].

2. Waveguide configuration and properties

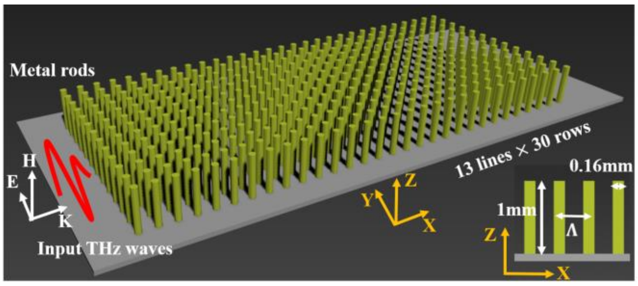

Fig. 1 The configuration of a MRA plasmonic slab waveguide.

Figure 1 shows the configuration of an MRA-based plasmonic slab waveguide, where the metal rod has the identical length about 1 mm and a 0.16 mm-diameter. In the research, the interspace of the MRA is investigated to obtain the optimal performance for the highest field confinement above the MRA and with the lowest waveguide loss. The experimental and simulation results show that the Bragg reflection occurs along the MRA wave guidance, which is found in a photonic crystal [Fig. 2(a)]. We take 0.302 THz and 0.519 THz waves as examples to observe the waveguide field confinement, respectively, at the low and high frequency ranges close to the photonic bandgap [Fig. 2(b)]. It is found the MRA guided waves in the low frequency range, 0.1–0.3 THz, obviously leak out of the MRA for 30-row propagation; contrarily, the THz waves in the high frequency range, 0.4–0.6 THz, can be highly confined. Field confinement measured by a knife-edge method is consistent to calculation results based on finite difference time domain (FDTD). When the MRA waveguide length is around 50 rows, THz field propagation loss is reduced to 0.02 cm^{-1} at 0.519 THz frequency [Fig. 2(c)].

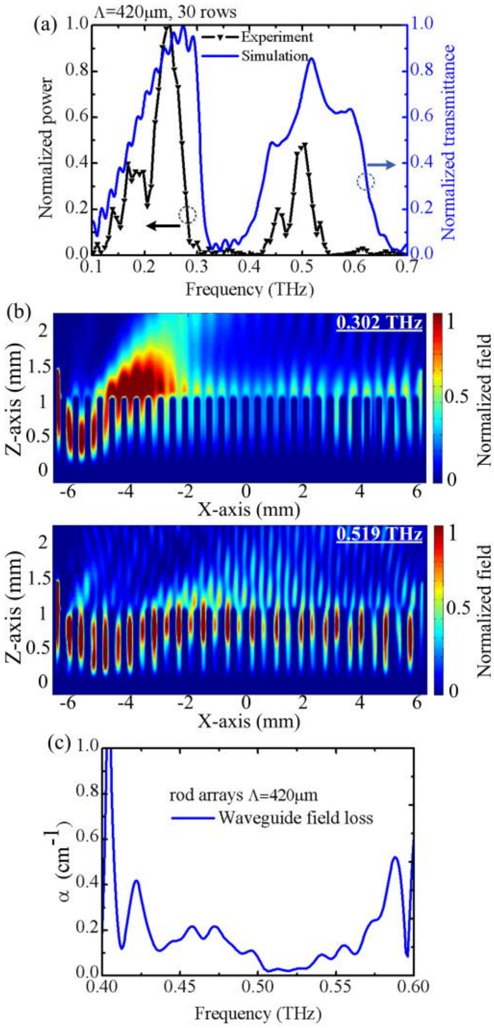

Fig. 2 (a) THz transmission spectra for the measurement and calculation results. (b) Longitudinal field distributions in the Z-X plane and at the MRA center of Y-axis for the 0.302 THz and 0.519 THz waves. (c) Calculated waveguide loss spectrum based on the wave propagation length between the 50- and 70-row MRAs.

References

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