Interaction Between EIT-like Metamaterials and THz Wave Absorb of Atmosphere

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***Abstract*—A kind of novel electromagnetic induced transparency like (EIT-like) metamaterials (MMs) has been proposed to explore the interaction between EIT-like MMs and atmosphere. This kind of metamaterials has been designed to show a EIT-like resonance around 0.56 THz. At the frequency where there is an absorb peak of terahertz (THz) wave in the atmosphere. Fabrication and maeasurement shows the interaction between EIT-like resonance and atmosphere enhance the transmission around 0.56THz obviously.**

I. INTRODUCTION

METAMATERIALS are artificial structures which have lots of novel characteristics that natural materials do not have. Devices based on metamaterials can modulate THz waves at will. By tailoring the geometry of the MMS in approptiate way, the specific modulation function can be obtained. EIT-like resonace can be induced by asymmetric structure [1]. A transparency window will emerge in the transmission spectra of this kind of resonance.Small change of local background will lead to obvious transmission spectral variation in the window frequency range. The atmosphere absorptivity of THz wave depending on consist of atmosphere, especialy the percentage of vapour [2].

Here, a structure which consists of two split-rings encircled by closed ring is designed, shown Fig. 1. This structure is symmetric in X-axis and asymmetric in Y-axiswhich will induce electromagnetic induced EIT-Like plasmonic Fano resonance. The upper layer is Au loss material withσ= 4.561×10^7 S/m and the substrate is silicon lossy material with ε=11.9. The parameters of this structure shown in Fig. 1.

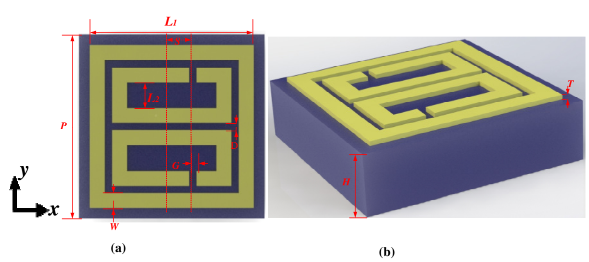

Fig. 1. The schematic of CRTS structure. (a) and (b) shows the configuration and the top view of CRTS structure. The parameters are: *P=75 μm, L1=66 μm, L2=10.5 μm, D=3 μm, G=3 μm, W=6 μm, S=7 μm, H=500 μm， T=0.2μm.*

II. RESULTS

Two typical samples have been chosen, which are B sample and C sample with *S*(S is the asymmetric degree)is 16μm and 0μm, respectively. Since in C sample S=0μm, which means it is symmetric, EIT-like resonace will not be excited. With the help of CST Suit Studio, transmission spectra has been simulated, shown in Fig. 2(a). These two sampleshave been measured by THz-time domain spectroscopy (TDS).A 10 mm thick, high-resistivity (4 kΩ · cm) silicon plate was placed in optical contact with the backside of the metamaterial substrate to make sure the EIT-window can be observed[3].

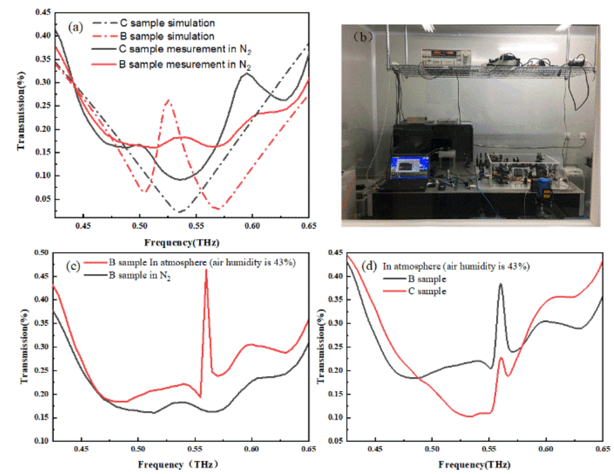

Fig. 2. The transmission spectra. (a) B sample and C sample simulation andmeasured in Nitrogen (N2) environmenttransmission spectra. (b)test equipment. (c) B sample and C sample measured in atmosphere (air humiditry is 43%). (d) B sample measured in N2 and atmosphere, respectively.

Comparing the simulation and measurment results in Fig. 2(a), it concludes that EIT- like resonance has been excited, that means the design is right. And Fig. 2(d) shows that the absorption of THz wave in atomosphere will influence the transmission spectra of the MMS, a sharp peak rises around 0.56 THz. In Fig. 2(c), comparing with the simulation the measurement of C sample tells us that the MMS resonate can coulpling with THz absorb of atmosphere[4]. This kind of MMS can reversal the absorption so as to enhance the transmission. What more, in Fig. 2(c), comparing with curve of C sample the curve of B sample, the EIT-like resonance bring a novel strong enhancementin transmission. Which means the EIT-like resonance will interact with the absorption of atmosphere and strongly enhance the transmission around 0.56 THz.

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