Phase jumping in multilayer metamaterials

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Electromagnetic wave experiences phase delay in propagation and also in resonance [1]. The control of electromagnetic wave phase delay is always a fundamental item to build other techniques based on phase information, such as interferometer, sensing, communication, etc. In this paper, we report a phase jumping phenomenon in multilayer metamaterial.

Metamaterial as an engineering material holds the ability to control electromagnetic wave both in propagation and resonance. Usually, metamaterials composed of metallic patterns show resonance under excitation [2]. Here, we report a metamaterial with double split ring resonators (SRRs) expresses inductor-capacitor (LC) resonance under normal incident electromagnetic wave incidence. By inserting a metallic block into the double SRRs, a phase jumping of 2π is observed when adjusting the block location from the middle of the double SRRs to 6.7 μm shifting from the middle, while the amplitude of the spectrum transmissions maintain similar for the two cases. Regarding to the electromagnetic wave wavelength of 300 μm at 1 THz, a 6.7 μm location shifting is in sub-wavelength region but introducing a 2π phase jumping, meanwhile keeping similar transmission. The reason lies in that the block modulates the resonance coupling between the double SRRs at their LC resonance, resulting in influence on the spectra that off from resonance. We find that the block location as well as the block size has significant influence to the resonance coupling. We will illustrate the procedure of how the block modulates the resonance coupling for both conditions in the presentation. From physics view, this work might help to investigate the coupled resonators system, while from application view, this work might help to design tunable metamaterial devices and sensing techniques.

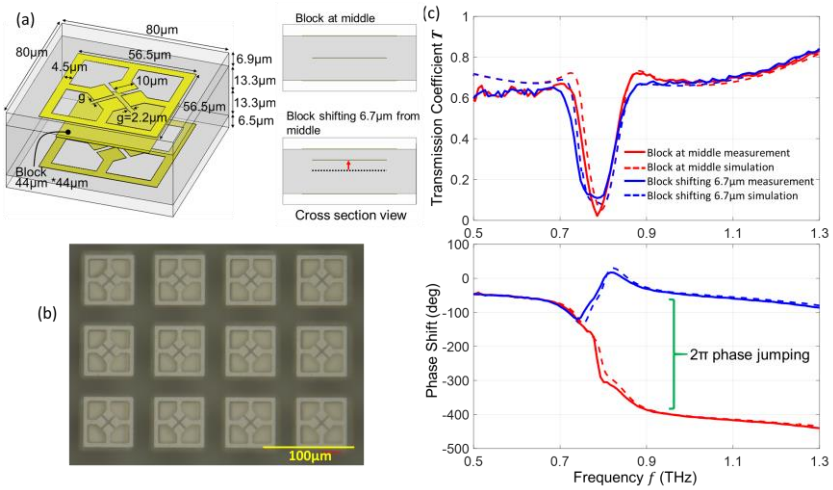

Fig.1 (a) schematic of multilayer metamaterial. (b) developed devices from top view. (c) Spectra performance, 2π phase jumping is shown when shifting the block 6.7 μm from middle location.

Acknowledgements: The authors would like to thank the micro system integration center (μSIC) of Tohoku Univ. for facility usage. This work was partly supported by RIKEN SPDR program and JSPS Kakenhi (17K18368).

[1] Optics Letters Vol. 43, Issue 12, pp. 2977-2980 (2018). [2] Optics Express Vol. 25, Issue 25, pp. 31186-31196 (2017).