Reflectionless ultra-thin microwave wave-plate based on metamaterials

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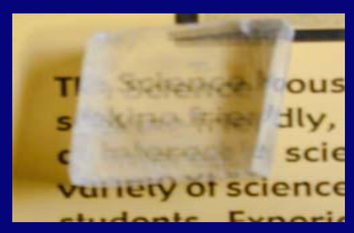
Abstract

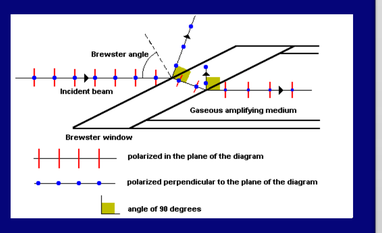
We design an anisotropic ultrathin metamaterial to allow perfect transmissions of electromagnetic (EM) waves for two incident polarizations within a common frequency interval. The transparencies are governed by different mechanisms, resulting in significant differences in transmission phase changes for two polarizations. The system can thus manipulate EM wave polarizations efficiently in transmission geometry.

Backgrounds

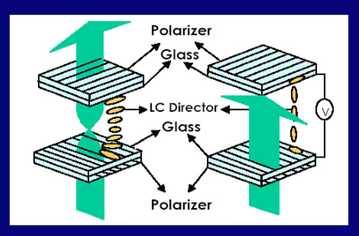
1. Polarization has widely applications
2. Some devices are too thick
3. Some devices loss energy



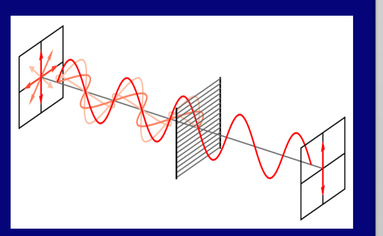
Birefringent crystals



Brewster effect



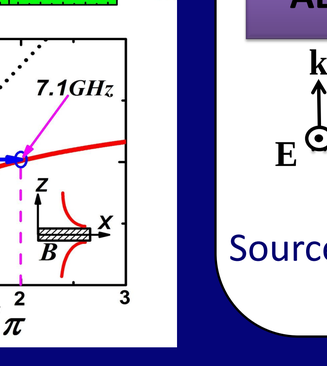
Liquid crystals

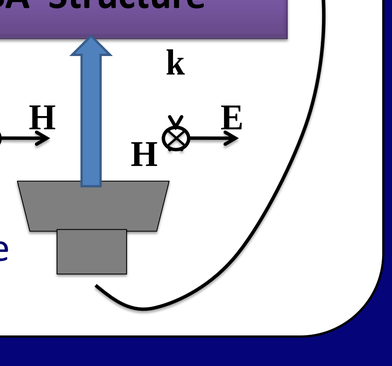


Wire-grid polarizer

Motivations

1. Anisotropic system
2. Independently transmission
3. Ultra thin
4. Different phase change

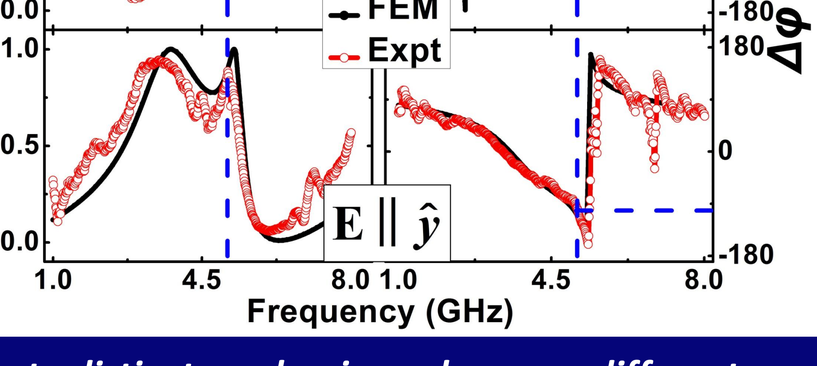




ABA perfect transparent system

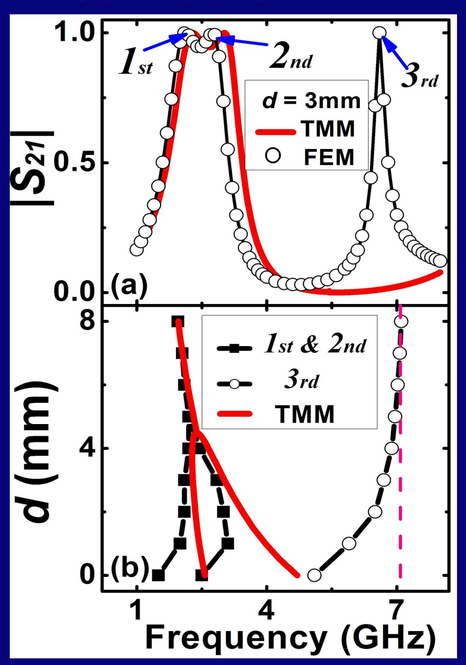
Structure

1. A layer: anisotropic electric metamaterials
2. B layer: metallic mesh
3. Thickness of air gap is tunable
4. Illuminated by a normal incident plane wave



Our designed structure

Realization



1st & 2nd based on EMT

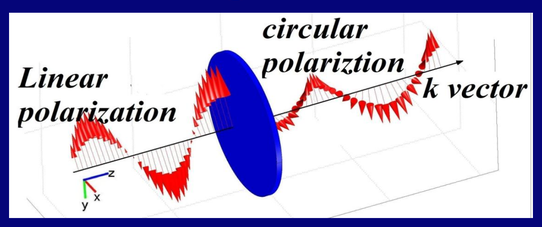
3rd based on EOT

Experiment

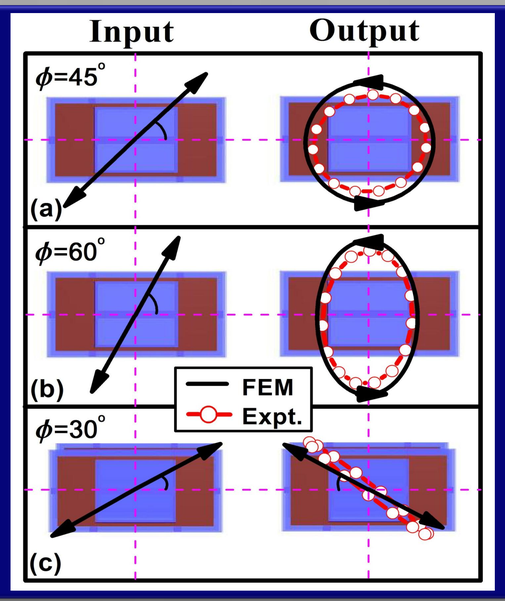
Independently tune the position of peaks:
3rd in x direction and 2nd in y direction in same frequency

Due to distinct mechanism, phase are different

Advantages



1. Flexibly controlling
2. Without energy loss
3. Completely conversion
4. ultra-thin



Conventional instrument	HD-38.1CWPS 
	Thickness
A Structure	0.6mm
B Structure	1.2mm
HD-38.1CWPS	160mm (38.1mm radius)

Freely cross-section in XY plane

Conclusions

1. Based on meta-materials
2. Distinct perfect transmission are realized simultaneously
3. Ultra-thin device flexibly control the polarization with perfect efficiency
4. Excellent agreement with theory and experiment

References:

(1) Lei Zhou, Weijia Wen, C. T. Chan, and Ping Sheng, Phys. Rev. Let. 94 243905 (2005)

(2) Jiaming Hao, Yu Yuan, Lixin Ran, Tao Jiang, Jin Au Kong, C. T. Chan, and Lei Zhou, Phys. Rev. Let. 99 063908 (2007)

(3) Wujiong Sun, Qiong He, Jiaming Hao, Lei Zhou, Opt. Lett. 36 927 (2011)

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