## **Polymer Metamaterials for Terahertz Wave Devices**

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Metamaterials have been demonstrated for different terahertz (THz) wave devices, such as bandpass filter, absorber, polarizer rotator, etc. However, since the metamaterial normally use a silicon or quartz substrate to accommodate the metallic split ring resonators (SRRs), different functional devices are usually separated and bulky for integration. In this paper, we propose to use polymer metamaterials [1] for THz wave devices for the integrated THz photonics. The polymer metamaterial includes double- or multi-layer SRRs and use thin polymer as the spacer between each layer to control the THz wave propagation. By designing the SRR structure with certain electromagnetic functions, it is available to integrate several type devices (filter, polarizer, etc.) into the one film. Meanwhile, it also benefits the nonlinear optics research by simply attaching the metamaterial film device onto the nonlinear crystal to improve the conversion efficiency with the electric field enhancement function by the SRRs [2].

As an example of the polymer metamaterial for integrated THz photonics, we design a sub-THz wave plate (**Fig. 1**) and metamaterial lens, which both are in thickness of sub-wavelength. Thanks to the flexibility of the thin film properties, the device are able to integrate with the conformal objects in the spectroscopy. Figure 1(a) shows the unit cell design of the wave plate, and Fig. 1 (b) shows the photo image of the thin polymer metamaterial device.



(a) unit cell of the metamaterial wave plate

rial wave plate (b) developed polymer metamaterial device Fig. 1 Polymer metamaterial device.

Acknowledgements: The authors would like to thank Prof. H. Ito of RIKEN/Tohoku Univ. and Prof. M. Kumano of Tohoku Univ. for fruitful discussions. The authors also thanks for micro system integration center (µSIC) of Tohoku Univ. for their facility and discussion for the device process. This work was supported partly by JST Collaborative Research Based on Industrial Demand, and partly supported by RIKEN SPDR research funding.

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