Birefringent Photonic Crystals for Polarization-discriminating Infrared Focal Plane Arrays

•Marc Lata[1], Yanzeng Li[1], Serang Park[1], Micheal J. McLamb[1], and Tino Hofmann[1,2]

1. Department of Physics and Optical Science, University of North Carolina at Charlotte, 9201 Uni. City Blvd., Charlotte, NC 28223, USA

2. THz Materials Analysis Center, Department of Physics, Chemistry, and Biology (IFM), Linköping University, SE 581 83 Linköping, Sweden

Infrared optical materials fabricated using direct laser writing have received substantial interest since the emergence of this technology which is based on the two-photon polymerization of suitable monomers [1, 2]. We have demonstrated that direct laser writing allows the fabrication of structured surfaces to reduce Fresnel reflection loss in the infrared spectral range while two-dimensional photonic crystals enable optical filters with high spectral contrast [3, 4]. In combination with the ability to fabricate large scale arrays of uniform structures, two-photon polymerization could be a disruptive technology for enhancing focal plane arrays in IR imaging systems.

So far, photonic crystals which provide polarization selectivity have not been used for the pixel-based enhancement of infrared focal plane arrays. Here we explore the form-birefringence found in photonic crystals composed of arrays of subwavelength-sized slanted micro wires (Fig. 1) for this purpose. The photonic crystals investigated here were fabricated in a single fabrication step using direct laser writing of an infrared transparent photoresist. The lateral dimensions of the photonic crystals are comparable to the pixel size of infrared focal plane arrays which is on the order of some tens of micrometers [5]. We observe a strong contrast under cross-polarized illumination in the mid-infrared spectral range at $\omega = 1550$ cm^{-1}. Finite-element-based techniques are used to optimized the geometry of the constituents of the photonic crystals to minimize edge effects. We envision laser direct writing as a suitable technique for the enhancement of focal plane arrays to enable focal-plane polarimeters for the infrared spectral range.

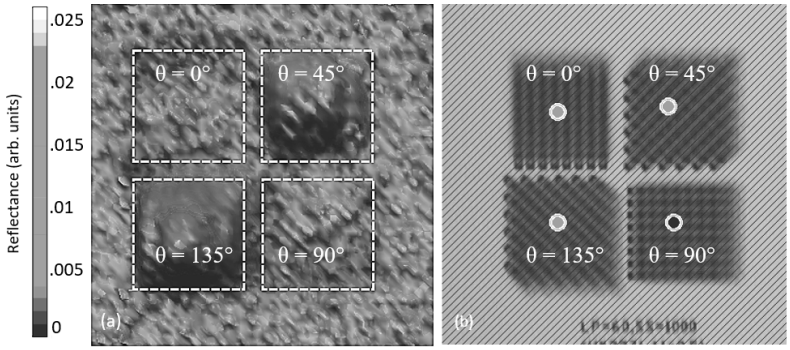

Fig. 1 (a) Polarization contrast image of four birefringent photonic crystals with a side length of 48 μm obtained under cross-polarized illumination at $\omega = 1550$ cm^{-1}. (b) Optical micrograph of these structures. The photonic crystals are composed of slanted micro wires with a slanting angle of 45°. The wire base and length are 3 μm×3 μm and 10 μm, respectively. The orientation of the slanting plane of the micro wires is indicated by θ.

References

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•mlata@uncc.edu