Digital metamaterials & micro-optics for photonics & imaging

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We apply fabrication-constrained numerical optimization to design metamaterials-based photonic devices comprised of discrete spatial pixels, which we refer to as *digital metamaterials*. Such devices include polarizers that can rotate one incident polarization, while allowing the orthogonal polarization to transmit undisturbed,[1] one-way mirrors, etc. When applied to integrated photonics, these concepts yield free-space-to-waveguide couplers,[2] polarization splitters,[3] mode converters, optical diodes,[4] wavelength splitters, vortex-mode converters, etc. Such devices are significantly smaller and more efficient than conventional ones.

Similar ideas can be applied in micro-optics enabling applications as diverse as ultra-lightweight multi-spectral and hyper-spectral imagers, fully transparent color filters in LCD displays and spectrum-splitting concentrators for solar energy.[5,6] By combining such micro-optics with computational algorithms, one can avoid expensive and heavy conventional optical elements, while enabling unique applications including ultra-high-bandwidth spectroscopy,[7] hyper-spectral[8] and light-field imaging, high-sensitivity (non-Bayer) color cameras, deep-brain imaging,[9] etc.

In this presentation, I will describe the design, fabrication, characterization and applications of these unique devices.

References:

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