Docket #: S16-118

Metamaterial Design and Fabrication for High Performance, Miniaturized Optical Systems

Stanford researchers patented a method to design, computationally optimize and fabricate efficient optical devices using semiconducting and dielectric nanostructures. The nanostructure blocks are used to build devices (metasurfaces) that manipulate light, optimizing particular optical responses in ultraviolet, visible, infrared, and terahertz frequency bands. The design method applies to single layers of nanostructures and generalizes to multiple layers of nanostructures stacked vertically. Bulky optical components are miniaturized, resulting in ultra-thin and compact optical systems with a wide range of applications.

Stage of Development - Prototype
Researchers demonstrated single layer silicon metasurfaces that efficiently operate as devices as diverse as gratings to large numerical aperture lenses in the full visible and near-infrared spectrum. They continue to refine their optimization methods, fabricate multilayer metasurfaces, and develop physical setups to characterize metasurface devices.

Applications

- A Wide Range of **Optical Systems** Including:
  - Augmented reality
  - Computational imaging
  - Compact cameras
  - Solar cells
  - Light emitting devices
  - Beam deflectors, splitters, and steering
  - Optical MEMs devices

    - RGB sorting lenses
    - Thermal management
    - Lenses, filters, etc. for color, hyperspectral and fluorescence imaging

Advantages

- Ultra-light and ultra-thin
- Versatile
- Easy to integrate with flat devices
- Broad range of optical responses, high efficiencies
- Device designs can be tailored to match fabrication/manufacturing constraints

Publications

- Sell, D., Yang, J., Doshay, S., & Fan, J. A. "Periodic Dielectric Metasurfaces with High-Efficiency, Multiwavelength Functionalities." Advanced Optical Materials, 5(23), 1700645. doi:10.1002/adom.201700645
- Sell, D., Yang, J., Doshay, S., Yang, R., & Fan, J. A. "Large-Angle, Multifunctional Metagratings Based on Freeform Multimode Geometries.." Nano Letters, 17(6), 3752-3757. doi:10.1021/acs.nanolett.7b01082
- Sell, D., Yang, J., Wang, E. W., Phan, T., Doshay, S., & Fan, J. A. "Ultra-High-Efficiency Anomalous Refraction with Dielectric Metasurfaces.." ACS Photonics, 5(6), 2402-2407. doi:10.1021/acsphotonics.8b00183
- Yang, J., Sell, D., & Fan, J. A. "Freeform Metagratings Based on Complex Light Scattering Dynamics for Extreme, High Efficiency Beam Steering.." Annalen Der Physik, 530(1), 1700302. doi:10.1002/andp.201700302

Patents

- Published Application: 20180045953
- Published Application: 20220299760
- Issued: 10,725,290 (USA)
- Issued: 11,543,653 (USA)

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