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Acoustically modulated photonic metasurface

Stanford researchers have developed an active photonic metasurface with fast and high-resolution optical control for light modulation devices.

Active photonic metasurfaces define and shape a light field by providing dynamic control over optical phase, amplitude, and polarization. While these devices have promise in expanding optical control beyond what is possible in devices with traditional optics, they require the fabrication of electrically active optical components which are smaller than the wavelength of light, a current challenge.

This technology exploits surface acoustic waves (SAWs) to mechanically modulate insulating gaps between plasmonic nanoparticles and a metallic surface. By inducing small deformations in the insulating gap filler between the nanoparticles and the metallic surface, the optical scattering properties can be altered significantly. The use of acoustic waves enables force to be precisely sculpted across the surface with subwavelength (1 µm) spatial resolution and allows for control with GHz bandwidths. Taken together, the technology provides dynamic optical control for lightweight, compact, and high-efficiency light modulation devices. These advantages could be harnessed in a wide range of applications in communications, sensing, display and imaging, including light detection and ranging (LiDAR), holographic displays, flat optics, and strain sensors.

Applications

- **Optical modulation** such as beam steering, fluorescence lifetime modulation, coupled exciton resonance modulation, and quantum emitter modulation
- **Light detection and ranging (LiDAR)**
- **Dynamic holographic displays**
- **Flat dynamic optics**

- **Strain sensors** and applications (e.g. Traction force microscopy)

Advantages

- **Remote placement of modulation electronics from the optical device** – avoids challenges and/or reduced performance due to integrating electronic modulation components into the optical elements
- **Fast and precise modulation** – compared to state-of-the-art optical control devices e.g. microoptoelectromechanical systems (optical MEMS)
- **Switchable with GHz bandwidths**

Innovators

- Skyler Selvin
- Mark Brongersma
- Majid Esfandyarpour
- Jung-Hwan Song

Licensing Contact

Luis Mejia

Senior Licensing Manager, Physical Sciences

Email