Docket #: S21-247

Geometric-Phase Metasurface Optofluidics for Dynamic On-Demand Transmissive Flat Optics & Ultra-Compact Refractometers

As part of a comprehensive optofluidic platform, researchers at Stanford have developed an integrated dynamic flat-optics system that supports unprecedented compact configurations. The technology is realized in a microfluidic system by flowing liquids (air) with different refractive indices on top of an optical phased array including a subwavelength-thick, engineered silicon nanoresonator array integrated on a transparent substrate. This technology enables the dynamic intensity and spectral control of the diffraction efficiency for any arbitrarily designed transmissive optical elements and phased arrays at visible frequencies. Either conventional optical elements such as lenses, prisms and gratings, or complex phased arrays such as structured light generators and holograms, can be made in an ultra-compact, flat fashion and be turned on and off as needed. Conversely, the diffraction efficiency of optical elements can be used as a sensor to monitor the refractive index change of the liquids flowing on top of it.

This technology is part of a portfolio showing how the convergence of optofluidics and metasurface optics can lead to new platforms for dynamic control of light fields. Explore more:
S21-246 – an integrated dynamic flat-optics system enabling microlens-free metasurface planar light-field displays.
S21-249 – a new type of reflective display technology for achieving transparent displays.

Stage of Development
The Brongersma team has demonstrated that their comprehensive platform offers a **wide range** of fundamental dynamic control functions, is realized using the **same**

material and by the **same processing**, and is **compatible** with mature microfluidic integration technologies.

Applications

- On-demand dynamic flat-optics
- Ultra-compact (spectrometer-free) refractometer for chemical and biological sensing
- May lead to the realization of micro-refractometers that enable new opportunities in medical diagnosis and treatment

Advantages

- Novel approach to realize arbitrarily designed diffractive optical elements
- Unprecedented sub-wavelength spatial resolution
- Liquids make on-demand optical elements dynamically
- Light-fields probe liquids in an unprecedented compact configuration
- No bulk optical elements such as prisms and spectrometers

Publications

- Li, Q., van de Groep, J., White, A.K. et al. Metasurface optofluidics for dynamic control of light fields. *Nat. Nanotechnol.* (2022).

Innovators

- Mark Brongersma
- Qitong Li
- Jorik Van De Groep
- Jung-Hwan Song

Licensing Contact

Luis Mejia

Senior Licensing Manager, Physical Sciences

Email