Vid. Proc. Adv. Mater., Volume 3, Article ID 2203265 **(2022)**

Optical Metasurfaces for Holography and Imaging Technology

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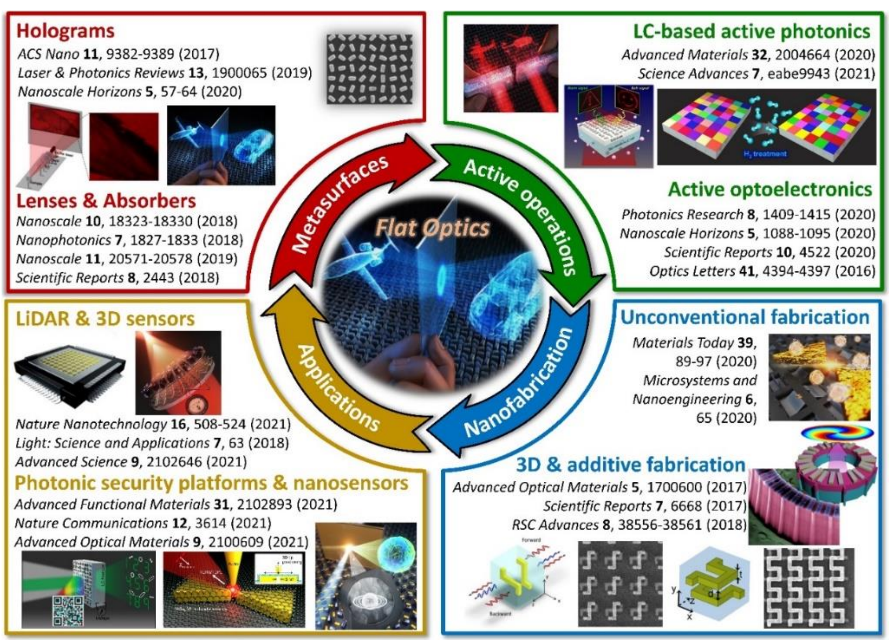
DOI: 10.5185/vpoam.2022.03265

Graphical Abstract

In this talk, I will briefly cover my previous research on metasurface-based flat optics. Particularly, I will introduce metasurface-based optical holographic displays and advanced imaging technologies.



Abstract

In this talk, I will introduce recent progress in metasurface enabled display and imaging applications. First, I will present high-efficiency interactive meta-holographic displays, which can switch holographic images according to external stimuli like voltage, heat and touch sensing [**1**]. For examples, the voltage-responsive metahologram is able to switch the holographic images within few milliseconds promising for real-time video holographic displays demanding 60 ~ 120 frames/s. Also, the heat or touch-responsive metaholograms can monitor external temperature and impact by visualizing different hologram images according to the pre-programmed external stimuli standard.

Such demonstrated systems may permit a diverse range of smart sensing and display applications such as smart hologram labels monitoring temperature/pressure/touch changes and interactive holographic displays recognizing haptic motions. Secondly, I will propose a compact gas sensor platform to autonomously sense the existence of a toxic volatile gas and provide an immediate visual holographic alarm [**2**]. By combining the advantage of the rapid responses to gases realized by liquid crystals with the compactness of holographic metasurfaces, we develop ultra-compact gas sensors without the requirement of additional complex instruments or machinery to report the visual information of gas detection. Thirdly, I will introduce a vectorial holographic color print for advanced security application [**3**]. The electrically tunable optical security platform aims advanced two-level encryption: Color printing image that can be decrypted by camera scanning provides first key and corresponding information will be used to fully unlock the double-encrypted information via projected vectorial hologram images. Also, such a strategy enables real-time video holographic displays with a single flat-optical device that does not demand a further external light modulator (e.g., spatial light modulator) or additional optical components. Finally, I will show an electrically tunable varifocal metalens that operates at visible wavelengths [**4**]. By combining a metalens with a liquid crystal cell, we are able to successfully demonstrate active switching between focal planes on the scale of milliseconds. Also, a point cloud generating metasurface for advanced 3D depth imaging or LiDAR application will be introduced. We believe such dynamic metaphotonic devices will further accelerate real-life applications such as video holographic displays, photorealistic full-color reflective displays, focus-tunable metalenses for AR/VR display, LiDAR [**5**], unconventional photonic sensors, wearable gas sensors and photonic security platforms.

Keywords: Metasurfaces, metaholograms, metalenses, liquid crystals.

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Biography of Presenting Author

Inki Kim is an Assistant Professor in Department of Biophysics, Institute of Quantum Biophysics at Sungkyunkwan University (SKKU). He received his Ph.D degree (with *Chang Kun Soo* Memorial Award) in Mechanical Engineering at Pohang University of Science and Technology (POSTECH), and B.S. degree (with highest honor) in Mechanical Engineering at Ulsan National Institute of Science and Technology (UNIST). Prior to joining SKKU, he was a *Sejong* Science Fellow in Mechanical Engineering at POSTECH. Currently his research interests are experimental nanoscale photonics including metamaterials, metasurfaces, plasmonics, nanofabrications, bionanophotonics, quantum biophysics, and quantum-integrated medical devices.

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