# Digitally tunable metasurfaces based on phase-change material

Qian Wang, Institute of Materials Research and Engineering (IMRE) (Singapore);
Shengtao Mei, National Univ. of Singapore (Singapore);
Guanghui Yuan, Nanyang Technological Univ. (Singapore);
Kian Shen Kiang, Univ. of Southampton (United Kingdom);
Nikolay I. Zheludev, Nanyang Technological Univ. (Singapore), Univ. of Southampton (United Kingdom);
Jinghua Teng, Institute of Materials Research and Engineering (IMRE) (Singapore)

A key recent advance in nanophotonics field has been the emergence of tunable, switchable and reconfigurable metasurfaces offering “optical properties on demand”. Various approaches have been developed to realize optical components made from metadevices reconfigurable by mechanical, electrical, or optical means. In general, however, most of the existing reconfigurable metasurfaces tune the properties over the entire device homogeneously when stimulated. In this work, we pioneered single-meta-molecule addressable digitally reconfigurable metadevices using the emerging paradigms of tunable metasurfaces - functional matter structured on the sub-wavelength scale, and by engaging new ideas of phase-change material integrated with nanostructures for dynamic light control. In our design, low loss dielectric nanostructures (amorphous Si nanorods) are patterned on top of phase-change foundation structures to form the hybrid meta-molecule. As for the phase-change medium, we use the chalcogenide glasses (e.g. germanium-antimony-telluride), which have pronounced contrast of dielectric properties observed between two phases. The laser-induced submicron-sized phase-change footprint allows us to address single meta-molecules individually. The reconfiguration of meta-molecules will be accomplished by re-amorphization of the phase-change material with a high-energy single optical pulse. The preliminary simulation results demonstrated the reconfigurable metasurfaces for phase and resonance frequency modulation of light based on the innovative platform of digitally and individually reconfigurable meta-molecules for applications in active beam shape and hologram display.