# Reconfigurable Gradient Metasurfaces With Random Access

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Since metamaterials have enabled the design of almost arbitrary landscapes of static optical properties and functionalities, dynamic temporal and spatial control over metamaterial properties has become the next big challenge [1]. Here we demonstrate the first randomly addressable reconfigurable metamaterials, thus enabling fast and high-contrast control over optical properties simultaneously in time and space.

Recently, we introduced mechanically reconfigurable metasurfaces driven by thermal, electrical and magnetic signals as a platform for tuning the properties of homogeneous metasurfaces [2, 3]. However, applications from transformation optics to holography require spatial resolution. Fig. 1 shows two implementations of random access reconfigurable metamaterials manufactured by focused ion beam milling from a 50 nm gold layer supported by a 50 nm thick silicon nitride membrane. Panel (a) shows a one-dimensionally reconfigurable metasurface consisting of free-standing gold-on-silicon nitride bridges, which can be individually electrically addressed and deform out of the device plane due to differential thermal expansion in response to resistive heating by the applied electrical current. Further action of a transversal magnetic field gives rise to Lorentz forces that can reinforce or oppose to thermal displacement. Panel (b) shows a two-dimensional 4x4 array of individually addressable metamaterials that deform within the device plane due to electrostatic forces between free-standing conductive beams in response to an applied voltage. In either case, local deformation of the nanostructure modulates the amplitude and phase of transmission and reflection of the semi-transparent nanostructure locally by modifying the near-field coupling between different meta-molecules and their plasmonic components, introducing means for creating reconfigurable gradient metasurfaces with desired properties in time and space.

The ability to apply the same or different control signals to all parts of such metadevices, allows operation as homogeneous or massively parallel phase and intensity modulators, gratings of switchable period, tuneable cylindrical lenses, high resolution spatial light modulators and – in principle – even tuneable transformation optics devices and holographic video displays.

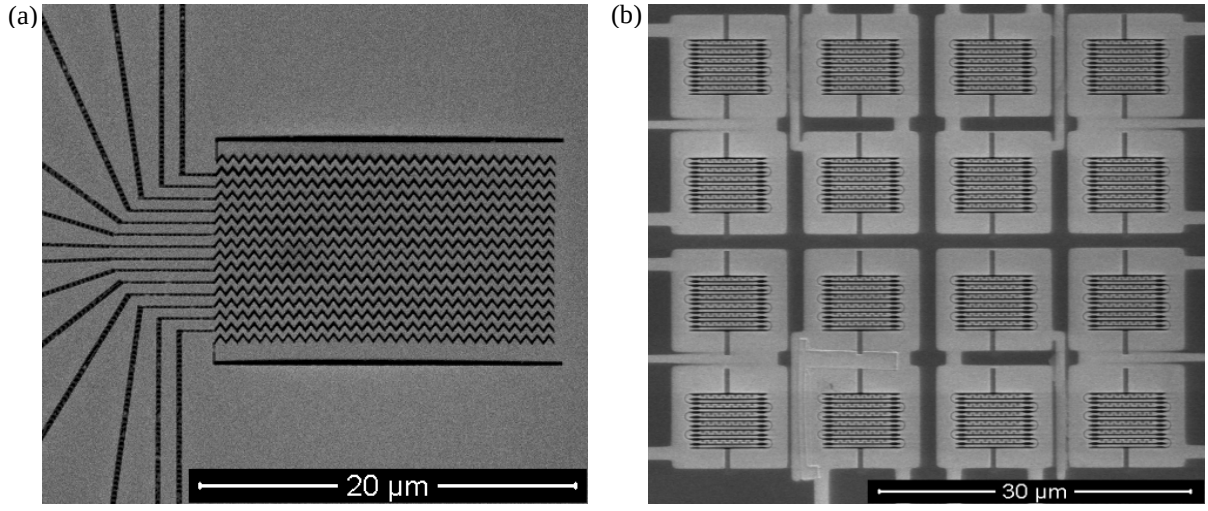


**Fig. 1.:** Electrically addressable reconfigurable metamaterials. (a) Photonic metamaterial with randomly addressable electrothermally reconfigurable rows of meta-molecules. (b) Randomly addressable array of electrostatically reconfigurable metamaterials.

## References

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