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MEMS-Actuated Metasurface Alvarez Lens

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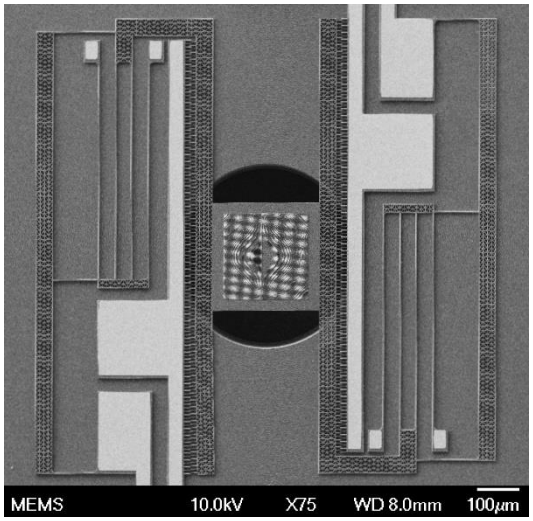
Abstract

We present a mass-producible miniature varifocal lens using MEMS-integrated meta-optics exploiting the concept of Alvarez lens to produce high tunability with low power consumption. The efficient comb-drive actuation with high energy density produces a maximum displacement range of 19 µm with input voltages below 40 V. The inverse-dependence of the focal length on the actuated displacement in an Alvarez system enables a focal tuning by 3.1 mm (200 diopters), more than an order of magnitude larger than the previous reports, constituting the largest focal length tuning in any low-power electro-mechanically actuated meta-optic devices. The consumed power is lower than 10 nW for DC operation and less than 1 µW for higher tuning frequencies into kHz. The novel fabrication process can accommodate meta-optics with a larger aperture onto a MEMS platform and improve alignment accuracy via flip-chip bonding, crucial for better optical performance during focal tuning. The entire fabrication process is CMOS compatible and amenable to high-throughput manufacturing, making such an integrated platform attractive for various applications requiring miniature tunable free-space optics.



MEMS-tunable Alvarez lens with
electrostatic actuation