Plasmonic Metafibers Electro-optic Modulators

FAYETTEVILLE, GA, USA, August 29, 2023 /EINPresswire.com/ -- Electro-optic modulators (EOMs) translating elcetrical signals into optical domains are indispensable elements in modern optical communications. Most target on-chip integrations, which inevitably suffer from high coupling losses and demanding optical alignments. Here, scientists from China developed a lumped EOM on the facets of a single-mode optical fiber jumper for fast amplitude modulations and dual-band operations. This work offers an avenue to 'plug-and-play' implementations of EO devices and ultracompact "all-in-fibers" operations for other optical systems.

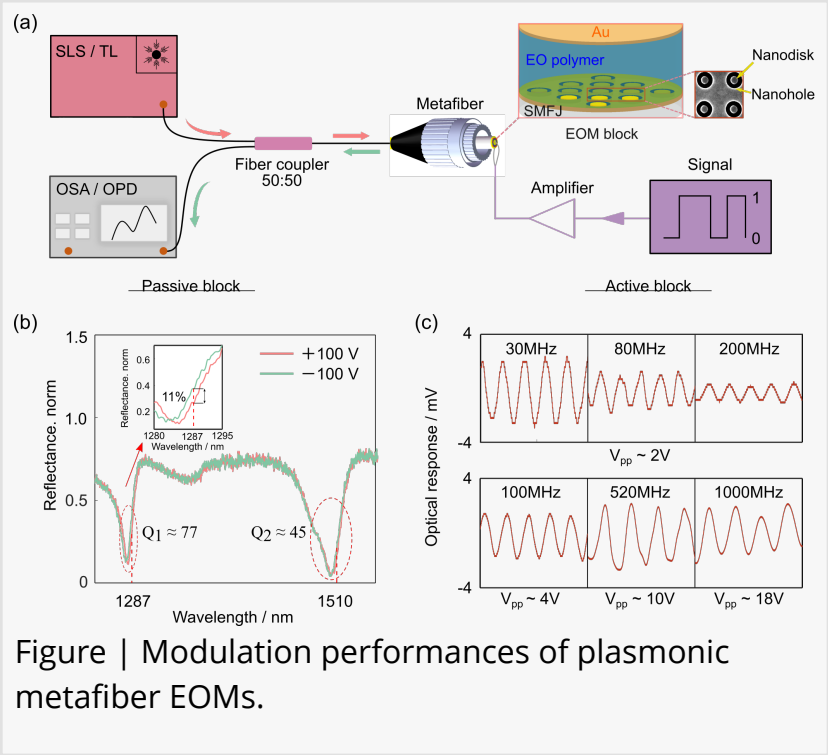

Figure | Modulation performances of plasmonic metafiber EOMs.

Electro-optic modulators (EOMs) are cardinal elements in the optical communication networks, which control the amplitude, phase and polarization of a light via external electric signals. Aiming to realize ultracompact and high-performance EOMs, the most investigations nowadays target on-chip devices that combine semi-conductor technologies with state-of-art tunable materials. Nevertheless, integrated EOMs, as an independent on-chip element, are commonly separated from light sources. Thus, extra interfaces couple the light from light sources to the waveguides of on-chip devices is indispensable. Although the state-of-art coupling schemes including edge coupling and grating coupling have been employed, they still suffer from limited integration densities and narrow-band operations, respectively. Besides, both coupling schemes require ultra-accurate alignments and complex encapsulations, making on-chip devices expensive for customers. Therefore, an EOM device that circumvents the coupling complexity and further reduce coupling losses is needed.

In a new paper published in Light: Science & Applications, a team of Chinese scientists, led by Professor Miu Qiu and Prof. Jiyong Wang from Key Laboratory of 3D Micro/Nano Fabrication and

Characterization of Zhejiang Province, School of Engineering, Westlake University and Ministry of Education Engineering Research Center of Smart Microsensors and Microsystems, School of Electrical and Information, Hangzhou Dianzi University developed the methodologies that directly integrate the EOM devices on the facet of single-mode optical fiber jumpers, connecting EOM devices with light sources using standard interfaces of optical fibers.
“Embracing the standard nanofabrication methodologies developed in our previous work, the EOM block can be directly integrated on the tips of single-mode optical fibers, so the metafiber EOMs intrinsically avoid the coupling treatment.” Prof. Min Qiu said.

Such plasmonic metafiber EOMs feature the well-defined plasmonic-organic hybrid configuration. Profiting from ultrathin and high quality-factor plasmonic metasurfaces, nanofabrication-friendly and highly efficient EO polymers, the spectral amplitude and quality-factor of passed light are well controlled to promote the resonance sensitivity for EO modulation.

“More interestingly, by rational designing the plasmonic modes, resonant waveguided modes and Fabry-Perot modes, tunable dual-band operations can be achieved in telecom O band and S band.” the co-first authors Lei Zhang and Xinyu Sun added.

The metafiber EOMs were further driven by direct/alternative current electrical signals. The modulation speed of metafiber EOM can reach as high as 1000 MHz with a bias voltage of ±9 V, which is the best performance for lumped fiber-integrated EOMs.

“Such metafibers EOMs provide new perspectives on designing ultracompact and high performance EO device for applications where compact configuration, highly integrated capability and low coupling loss are required, such as in active mode-locking fiber lasers and tunable broadband fiber polarizers. This work also offers an avenue to ‘plug-and-play’ implementations of EO devices and ultracompact “all-in-fibers” optical systems for communications, imaging, sensing and many others.” Prof. Jiyong Wang added.

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