



## Conductive Oxides Trench Structures as Hyperbolic Metamaterials in Mid-infrared Range

Takayama, Osamu; Shkondin, Evgeniy; Panah, Mohammad Esmail Aryaee; Repän, Taavi; Malureanu, Radu; Jensen, Flemming; Lavrinenko, Andrei

*Publication date:*  
2016

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Takayama, O., Shkondin, E., Panah, M. E. A., Repän, T., Malureanu, R., Jensen, F., & Lavrinenko, A. (2016). Conductive Oxides Trench Structures as Hyperbolic Metamaterials in Mid-infrared Range. Abstract from 14th International Conference of Near-Field Optics, Nanophotonics and Related Techniques, Hamamatsu, Japan.

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# Conductive oxides trench structures as hyperbolic metamaterials in mid-infrared range

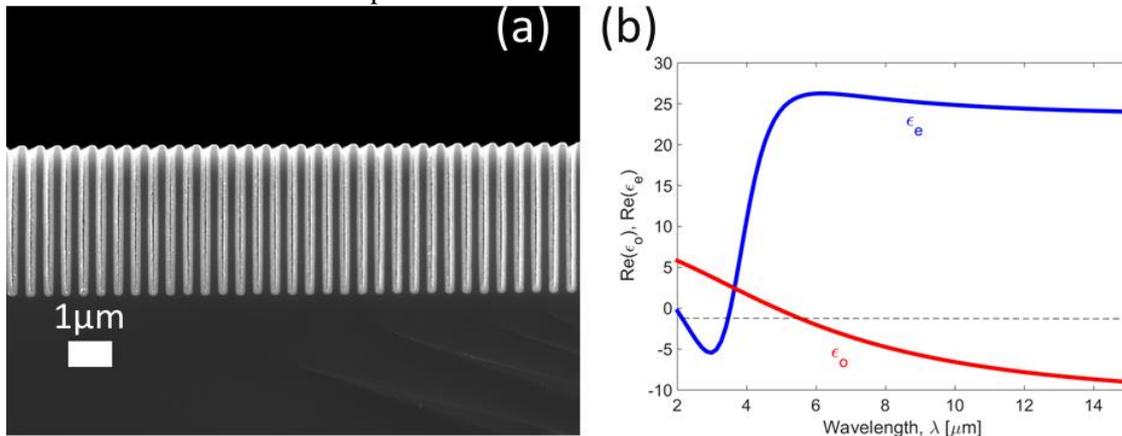
O. Takayama<sup>1</sup>, E. Shkondin<sup>1,2</sup>, M. E. Aryaee Panah<sup>1</sup>, T. Repän<sup>1</sup>, R. Malureanu<sup>1</sup>, F. Jensen<sup>2</sup>, and A. V. Lavrinenko<sup>1</sup>

<sup>1</sup> DTU Fotonik—Department of Photonics Engineering, Technical University of Denmark, Ørstedes Plads 343, DK-2800 Kgs. Lyngby, Denmark

<sup>2</sup> DTU Danchip—National Center for Micro- and Nanofabrication, Technical University of Denmark, Ørstedes Plads 347, DK-2800 Kgs. Lyngby, Denmark  
otak@fotonik.dtu.dk

Nanostructures that possess hyperbolic iso-frequency contours exhibit unique properties of high anisotropy and extremely large wavevectors, which are the key issue to numerous photonic applications from subdiffraction imaging and superlens to sensing and spontaneous emission enhancement [1,2]. Moreover plasmonics for mid-infrared offer unique applications such as bio-sensing, thermal imaging and quest for novel materials and structures has been continuing [3]. In this report we show that vertical trench structures made of, for example, aluminum-doped ZnO (AZO) or other transparent conductive oxides can function as hyperbolic metamaterials (HMMs) for the mid-infrared wavelength region.

We fabricated a probe sample by a combination of atomic layer deposition (ALD) and dry etch techniques. We templated a Si wafer with deep UV photolithography and made trenches by deep reactive ion etching. Subsequent deposition of an AZO layer by the ALD technique forms vertical AZO trenches with a high aspect ratio (Fig.1a). After homogenization procedure the structure exhibits hyperbolic dispersion (Fig.1b) serving as an attractive platform for light manipulation [4]. Characterization results will be reported at the conference.



**Fig. 1:** (a) Electron micrograph image of fabricated Al-doped ZnO (AZO) structures between Si trenches with high aspect ratio. (b) Effective ordinary and extraordinary permittivities,  $\epsilon_o$  and  $\epsilon_e$  of the AZO trench structure based on effective media approximation, showing the hyperbolic properties of the structure for wide range of mid-infrared wavelength region.

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