

Tunable terahertz band-pass filters based on antiferromagnetic resonance

Y. Ivonyak,^{1,2} N. Charrouj,¹ and M. Białek¹

¹*Centera, IHPP Polish Academy of Sciences, Warsaw, Poland*

²*Centera, Cezamat, Technical University of Warsaw, Poland*

The terahertz (THz) frequency range lacks compact and tunable narrow-band optical components, limiting its technological deployment. Here we demonstrate a temperature-tunable THz filter based on antiferromagnetic resonance (AFMR) in a canted antiferromagnetic crystal. Using yttrium ferrite (YFeO₃), we exploit the resonant Faraday effect associated with AFMR, which induces a strong rotation of the polarization of linearly polarized THz radiation. In a cross-polarized transmission geometry, this results in a narrow transmission peak centered at the magnon resonance frequency, effectively realizing a band-pass filter. By varying the crystal temperature up to 600 K, the AFMR frequency is tuned over the range 200–300 GHz. At resonance, we observe Faraday rotation approaching 90 degrees, leading to high transmission contrast. This frequency range overlaps with an atmospheric transmission window characterized by reduced water-vapor absorption, making the demonstrated approach relevant for future THz communication and remote-sensing applications. While the underlying magneto-optical effects are well established, our results highlight their potential for functional THz devices and establish antiferromagnetic crystals as tunable narrow-band filters in the THz regime.

This work was also partially supported by the Sonata Bis-13 2023/50/E/ST3/00584 grant of the National Science Centre of Poland