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Ternary composite g-C₃N₄/MXene/Co₃O₄ as an efficient SA for 2-μm mode-locked fiber lasers

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Abstract

There is a growing demand for ultrashort fiber lasers at 2.0 μm due to their important role in cutting-edge fields such as spectroscopy, clinical surgery, and optical telecommunications. While standard two-dimensional (2D) materials are widely used as passive saturable absorbers (SAs), their performance is often limited by low modulation depths and structural degradation, such as oxidation. To overcome this, a novel ternary nanocomposite of g-C₃N₄/MXene/Co₃O₄ was fabricated and integrated into a mode-locked thulium-doped fiber laser (TDFL) cavity as a highly efficient SA. Nonlinear optical characterization of the integrated SA shows a higher modulation depth of 20.3% and a high saturation intensity of 39.4 MW/cm². It produced ultrashort 1.3 ps pulses at 1927.8 nm and a fundamental repetition rate of 17.67 MHz. The cavity demonstrates outstanding long-term operational stability, with minimal spectral or temporal drift over a continuous 300-minute observation period and a signal-to-noise ratio (SNR) of 44.3 dB. These results establish that the g-C₃N₄/MXene/Co₃O₄ nanocomposite has the potential to serve as an optical modulator for advancing ultrafast nonlinear photonics in the mid-infrared regime. © 2026 Elsevier B.V.

Author keywords

2D Materials; G-C₃N₄/MXene/Co₃O₄; Mode-locked; Ternary composite; Thulium-doped fiber

Indexed keywords

Engineering controlled terms

Fibers; Light modulators; Locks (fasteners); Mode-locked fiber lasers; Nonlinear optics; Optical signal processing; Pulse repetition rate; Saturable absorbers; Thulium

Engineering uncontrolled terms

Clinical surgery; Cutting edges; G-c₃n₄/mxene/co₃o₄; Growing demand; Mode-locked; Modulation depth; Optical telecommunication; Ternary composites; Thulium-doped fibers; Two-dimensional

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Engineering main heading

Fiber lasers

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Details about financial support for research, including funding sources and grant numbers as provided in academic publications.

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