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Calcium-molybdenum-cobalt-2-methylimidazole trimetallic organic framework as a saturable absorber for passive mode-locked thulium–holmium doped fiber lasers

[Scientific Reports](#) • [Article](#) • [Open Access](#) • 2026 • DOI: 10.1038/s41598-026-50198-7 [Ahmad, Harith](#)^{a, c} ; [Mokhtar N.](#)^a; [Rusni N.A.M.](#)^{a, b}; [Sa'ad M.S.M.](#)^a; [Imaduddin I.S.](#)^d; [+6 authors](#)^a Photonics Research Centre, Universiti Malaya, Kuala Lumpur, 50603, Malaysia[Show all information](#)

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Abstract

Ultrafast fiber lasers operating in the 2 μm spectral region require robust and highly nonlinear saturable absorbers (SAs) to achieve stable mode-locking. This study demonstrates that a calcium-molybdenum-cobalt-2-methylimidazole (CaMoCo-MIM), a trimetallic organic framework (TMOF), functions as an efficient SA, enabling stable and self-starting mode-locking pulse in a thulium–holmium-doped fiber laser (THDFL). The CaMoCo-MIM exhibits excellent nonlinear optical performance, achieving a high modulation depth of 36.2%, surpassing many previously reported MOF-based SAs, as supported by the comparative data presented in this study. Stable soliton pulse generation was realized at a pump power of 307 mW, producing a central wavelength of 1895.21 nm, a 3 dB spectral bandwidth of 3.03 nm, and a pulse duration of 1.25 ps. A time-bandwidth product (TBP)

of 0.316 indicates a nearly chirp-free pulse. Long-term operation over four hours confirmed robust stability with a constant repetition rate of 14.6 MHz. This TMOF establishes a high-modulation-depth SA in next-generation lasers. © The Author(s) 2026.

Author keywords

calcium-molybdenum-cobalt-2-methylimidazole; mode-locking pulse; saturable absorber; thulium-holmium doped fiber lasers; trimetallic organic framework

Indexed keywords

EMTREE drug terms

calcium; holmium; thulium

EMTREE medical terms

adult; article; bandwidth; controlled study; duration; female; fiber; laser; nonhuman; pulse rate

Chemicals and CAS Registry Numbers

Unique identifiers assigned by the Chemical Abstracts Service (CAS) to ensure accurate identification and tracking of chemicals across scientific literature.

calcium	7440-70-2, 14092-94-5
holmium	7440-60-0
thulium	7440-30-4

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Universiti Malaya See opportunities by UM ↗	RU001-2025 A.	UM

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