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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

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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.

Keywords **Author Keywords:** [calcium-molybdenum-cobalt-2-methylimidazole](#) ; [trimetallic organic framework](#); [saturable absorber](#); [thulium-holmium doped fiber lasers](#); [mode-locking pulse](#)
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The datasets analysed during this study are available from the corresponding author on reasonable request.

Conflict of interest statement

The authors declare no competing interests.

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