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High-Energy Ultrafast Fiber Laser at 2- μ m Based on Cb Ni-Metal Organic Framework

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[Ahmad, Harith](#)^{a, b, c} ; [Zaini, Muhammad Khairol Annuar](#)^a ; [Mahmoodin, Zulkifli](#)^d ; [Mutlu, Saliha](#)^{e, f} ; [Filiz, Volkan](#)^g ; [+5 authors](#)

^a Universiti Malaya, Photonics Research Centre, Kuala Lumpur, 50603, Malaysia

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Abstract

A new carborane-containing metal-organic framework (Cb Ni-MOF) was synthesized using a high-power laser-assisted method. The material was prepared from Nickel(II) chloride hexahydrate ($\text{NiCl}_2 \cdot 6 \text{H}_2\text{O}$) and m-carborane-1,7-dicarboxylic acid (Cb). FTIR spectroscopy-based structural analysis confirmed successful coordination between the carborane carboxylate groups and Ni(II) ions. SEM-based morphological description revealed 200 nm to 1 μ m-sized polyhedral particles, indicating a crystalline and porous nature. TEM images further revealed nanoscale crystallinity with particle diameters around 50 nm, together with single-/polycrystalline structures with identical features. These findings demonstrate that the laser-assisted process is efficient for preparing nano-ordered, highly crystalline Cb-based MOFs. In this work, the generation of a high-performance ultrafast fiber laser system at the 2- μ m wavelength region was demonstrated. The system utilized a passively mode-locked oscillator incorporating a Cb Ni-MOF deposited on an arc-shaped fiber, demonstrating exceptional nonlinear optical properties with 14.1% modulation depth and 11.2 MW/cm^2 saturation intensity. The laser oscillator generated ultrashort pulses with a duration of 1.2 ps at a center wavelength of 1942.9 nm. Using a chirped pulse amplification (CPA) technique with pre-amplification and main amplification stages, the high-power fiber laser achieves remarkable performance characteristics: 8.4 W average output power, 264 fs pulse duration, 433 nJ pulse energy, and 1.64 MW peak power at 19.4 MHz repetition rate. This high-power ultrafast fiber laser system shows significant potential for applications in invasive medical

procedures, advanced material processing, and other fields requiring precise and high-intensity laser-matter interactions. © 1965-2012 IEEE.

Author keywords

High-energy ultrafast fiber laser; high-power laser-assisted synthesis (LIRS); metal-organic frameworks; thulium-doped fiber

Indexed keywords

Engineering controlled terms

Carboxylation; Chlorine compounds; Chromium compounds; Crystalline materials; Crystallinity; Fiber lasers; Fibers; High power lasers; Iodine compounds; Laser materials processing; Metal-Organic Frameworks; Nickel compounds; Nonlinear optics; Optical properties; Organic lasers; Oscillators (electronic); Ultrashort pulses

Engineering uncontrolled terms

Carboranes; Energy; High-energy ultrafast fiber laser; High-power laser-assisted synthesis (LIRS); High-power lasers; Laser systems; Laser-assisted; Metalorganic frameworks (MOFs); Thulium-doped fibers; Ultrafast fiber lasers

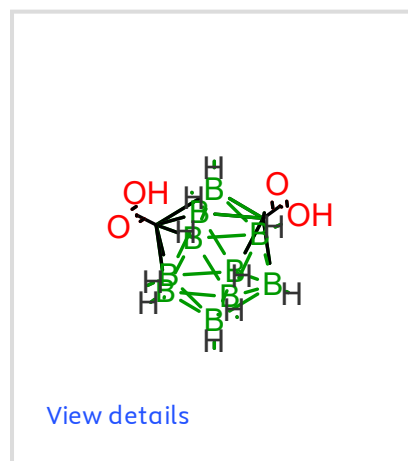
Engineering main heading

Pulse repetition rate

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Substances



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Corresponding authors

Corresponding author	H. Ahmad
Affiliation	Universiti Malaya, Photonics Research Centre, Kuala Lumpur, 50603, Malaysia
Email address	harith@um.edu.my

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