Inverse Saturable Absorption in NALM Mode-Locked Fiber Laser

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Abstract

The state-of-the-art mode-locked erbium-doped fiber lasers with a non-linear amplifying loop mirror (NALM) still have a low repetition rate. For the non-polarization-maintaining scheme, the highest is 257 MHz [1]. For the polarization-maintaining scheme, the highest is 250 MHz [2]. For the mode-locked fiber laser with a NALM, the self-starting of mode-locking is closely related to the differential non-linear phase shift (NPS). Thus, the cross-phase modulation (XPM) effect definitely makes a contribution to pulse formation and self-starting in the mode-locked fiber lasers, which has not been thoroughly studied yet.

In order to overcome the difficulties of increasing the repetition rate and analyze the influence of XPM on self-starting of mode-locking, we calculate the power distributions of two counterpropagating beams in the NALM and the differential NPS accumulations. Our analysis is carried out from the perspective of NPS accumulation. We find a difference between the differential NPSs for the CW light and the pulses in the fiber loop, which makes the NALM show an inverse saturable absorption (ISA) mechanism during the pulse formation. The ISA has been extensively studied in the real saturable absorber [3], but not in the artificial saturable absorber. The ISA in the NALM could be used to explain the experimental phenomena that the mode-locking of laser can be actively started by tapping fiber, fine-tuning light polarization, or other disturbances. These results are helpful for optimizing the design of NALM and lowering the self-starting threshold of the high-repetition-rate mode-locked fiber laser.

Biography

Haobin Zheng received the B.S. and M.S. degrees from National University of Defense Technology, Changsha, Hunan province, China.

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