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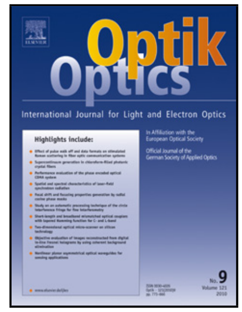

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Numerical investigation of dissipative solitons in net normal-dispersion erbium-doped fiber lasers

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Abstract: The evolution of dissipative solitons (DSs) in passively mode-locked erbium-doped fiber lasers with net normal-dispersion has been investigated numerically. Numerical results show that the net cavity dispersion (D_{net}), the output coupling ratio (η), the bandwidth of the spectral filter (SFBW) and the gain saturation energy of the Er-doped fiber (E_{sat}) all affect the pulse energy, profile and stability of the DSs. It was found that by adding a segment of dispersion compensation fiber (DCF) to build a highly positive dispersion regime, combining the actions of an amplitude modulator and a spectral filter, and choosing an optimal output coupling ratio, stable, high-energy dissipative solitons could be obtained.

Key words: fiber laser, dissipative solitons, net normal-dispersion, spectral filter, dispersion compensation fiber.

1. Introduction

Ultrashort pulse fiber lasers have attracted much attention because of their wide applications in micromachining, surgical medicine, imaging and optical telecommunications [1-3], and as a result, how to increase the energy of ultrashort pulses has become a central research focus. Recently, a series of theoretical and experimental studies have demonstrated that the pulse energy in mode-locked fiber lasers depends strongly on the cavity dispersion, and have shown that net- or all-normal-dispersion fiber lasers should be able to achieve high energy pulses. Since the formation of these pulses is based on the balance between the dispersion, nonlinearity, the energy gain and loss in the laser, the pulses have been named Dissipative Solitons (DSs) [4-6]. In 2007, stable and self-starting DSs were generated with energies above 20 nJ in an Yb-doped fiber laser (YDFL) [7]. In 2012, by stepwise variation of the resonator dispersion, total fiber length and the spectral filter bandwidth, Chichkov et al. experimentally produced 84 nJ DSs in an all-normal-dispersion Yb-doped double-clad fiber laser [8].

At present, YDFL DSs with high pulse energy are seeing great development due to the higher efficiency and wider gain bandwidth of Yb-doped fibers. For the erbium-doped fiber laser (EDFL), using net- or all-normal-dispersion fiber lasers to form DSs remains a challenge, since the majority of fiber components have an anomalous second order group velocity dispersion (GVD) at the operational wavelengths of Er-doped fiber (EDF). In order to overcome this drawback, a dispersion compensation fiber (DCF), which can present a positive GVD at 1.5 μm,