amplification. Under beam shaping technique, achieving high energy square pulses can be realized by exploiting the dissipative soliton resonance theory where the energy is not limited by the soliton area theorem and it increases proportionally with allows the pulse width to widen linearly.

Dissipative soliton resonance square pulses were experimentally observed in setups consisting on the nonlinear polarization evolution mechanism in normal and anomalous dispersion regimes. It has also been demonstrated in mode-locked figure-of-eight fiber lasers using optical circulators and dual pumping. These results highlighted the fact that the high non-linearity plays an important role in widening the pulse.

In this work, we present a widely adjustable high energy square pulse laser operating in dissipative soliton resonance in a passively mode-locked figure-of-eight fiber configuration using dual Er:Yb co-doped double clad amplifiers. By manually controlling the power of each amplifier, the pulse width can be varied in a range of 360 ns without generating multi-pulsing instabilities. To ensure that DSR would dominate the mode-locking mechanism, we use a 1.5 km standard single-mode fiber in the cavity. At a maximum pumping power, the laser generated square pulses with 416 ns duration and an average output power of about 1.33 W with a repetition frequency of 133 KHz corresponding to a record pulse energy of 10 ?J.

10228-24, Session 5

Bright-dark rogue wave in mode-locked fibre laser

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Rogue waves (RWs) are statistically rare localized waves with high amplitude that suddenly appear and disappear in oceans, water tanks, and optical systems [1]. The investigation of these events in optics, optical rogue waves, is of interest for both fundamental research and applied science. Recently, we have shown that the adjustment of the in-cavity birefringence and pump polarization leads to emerge optical RW events [2-4]. Here, we report the first experimental observation of vector bright-dark RWs in an erbium–doped stretched pulse mode-locked fiber laser. The change of induced in-cavity birefringence provides an opportunity to observe RW events at pump power is a little higher than the lasing threshold. Polarization instabilities in the laser cavity result in the coupling between two orthogonal linearly polarized components leading to the emergence of bright-dark RWs. The observed clusters belongs to the class of slow optical RWs because their lifetime is of order of a thousand of laser cavity roundtrip periods.

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10228-25, Session 5

Rogue waves driven by polarization instabilities in a long ring fiber oscillator

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We present the results of an experimental and theoretical study of the complex nonlinear polarization dynamics leading to rogue wave’s emergence. The theoretical model consists of seven coupled non-linear equations and takes in account both orthogonal states of polarizations (SOPs) in the fiber [1, 2]. The model predicts the existence of seven eigenfrequencies in the cavity due to polarization instability near lasing threshold. By adjusting the laser parameters (the power and the SOP of the pump wave and in-cavity birefringence) we can tune some eigenfrequencies from completely different (non-degenerate states) to coinciding (degenerated states). The experiments were performed with a passively self-mode-locked erbium-doped fiber oscillator implemented in a ring configuration and operating near the lasing threshold. The obtained experimental results are in a good correspondence with the theory. Moreover, it was observed that non-degenerate states of oscillator lead to L-shaped probability distribution function (PDF) and true rogue waves (RWs) regime. Meanwhile, a small detuning from partially degenerated case also leads to L-shaped PDF with the tail trespassing RW threshold, but gives periodic patterns of pulses. This regime probably cannot be considered as a true RWs scenario because of high grade of predictability of the patterns. The partial degeneration, in turn, guides to quasi-symmetric distribution rather typical for white noise than for RWs regime.

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10228-26, Session 6

Photoinduced ?(2) for second harmonic generation in stoichiometric silicon nitride waveguides

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Stoichiometric silicon nitride (Si_3N_4) waveguides, grown via low pressure chemical vapour deposition (LPCVD), are a reliable photonics platform characterized by low loss and a broad transparency range, from the visible to the mid-infrared. Engineering the waveguide dispersion is of special interest since it allows phase-matching of third-order nonlinear optical processes such as four-wave mixing, supercontinuum [1] and frequency comb generation. In the related material SiN, grown with sputtering and PECVD, second order processes have been observed already. Since SiN deposited with these techniques is amorphous and should therefore posses no bulk ?(2), fabrication imperfections such as strained micro-crystalline silicon or at the free nitrogen dangling bonds are seen as the origin [2]. Field enhancement in SiN ring resonators and Bragg gratings have been used to increase the conversion efficiency for SHG to a maximum of 0.14% [3].

Here, we present for the first time experimental evidence of photoinduced ?(2) for SHG in stoichiometric LPCVD-grown Si_3N_4 waveguides. The waveguides were designed to phase match the horizontally polarized TEM00 mode at 1064 nm with the second order transverse mode TEM02 at 532 nm. A mode-locked laser delivering 6 ps pulses at 1064 nm with a 20 MHz repetition rate was used as pump laser. However, initially, at fixed input pump power, no SHG was observed. Only after longer irradiation, around 1000 s, 532 nm light was observed to grow from below noise to a saturated value, which indicates the presence of a photoinduced ?(2). We obtained a conversion efficiency close to 0.4%, corresponding to 41 μW at 532 nm with 10 mW of IR light measured after the collection lens positioned directly after the waveguide.

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