Ytterbium Mode-Locked Fiber Laser with Single-Wall NanoTubes as Saturable Absorber

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Abstract— We report on development of 1mkm master oscillator generating 6.6 ps, 250 pJ soliton-like pulses. The selfstarting CW mode-locking is realized in ytterbium all-fiber ring laser with PM architecture using specially designed saturable absorber based on single-wall carbon nanotubes.

Keywords—mode-locking; SWNT; ytterbium; soliton

I. INTRODUCTION

Generation of high energy picosecond pulses at the wavelength of 1 mkm is a subject of intensive investigation due to its practical demands. Realization of such lasers in fiber format can be especially fruitful because of highly developed fiber technology. One of the most popular approaches is MOPA laser scheme with Master Oscillator based on passive mode locking (ML) with SESAM [1]. Although huge progress has been made in improving quality and lifetime of SESAM, another saturable absorbers should be investigated. This paper briefly presents results of ytterbium picosecond pulse laser based on ML with Single-Wall NanoTubes (SWNT) as saturable absorbers.

II. LASER SCHEME

Erbium lasers with SWNT are rather well investigated [2]. The optical scheme of designed Yb laser is presented on Fig. 1. All elements in the scheme are coupled with polarization maintaining (PM) fiber and circulator blocks fast axis. The applied PM architecture format provides suppression of the nonlinear polarization evolution effect, and make the resonator independent on twisting the fiber. The High Reflective Chirped Fiber Bragg Grating (HR FBG) is to make the total dispersion of the resonator anomalous. The applied PM WDM is specially designed to have 100%/0% coupling ratio at 980 nm and 5%/95% at 1060 nm lasing wavelength. The mode-locked lasering regime of the scheme is provided by specially designed fast film-like saturable absorber based on SWNT [3].

About 30% linear transmission of SWNT SA in a wide spectral band centered at 1mkm and typical ultrafast relaxation dynamics is shown on Fig.1. To integrate the SA into the resonator the thin film incorporating SWNT was either clamped between two optical FC-APC or placed in the air gap between two focusing lenses.

III. RESULTS AND FUTURE PROSPECTS

The selfstarting CW mode-locked Yb fiber laser with SWNT SA was designed. The laser provides generation of 250 pJ picosecond single pulses at 15 MHz. As can be seen from autocorrelation and spectrum measurements (see Fig.3) the pulses with duration of 6.6 ps and spectrum width of 0.25 nm were generated. Sharp sidebands in the spectrum appear from the periodic perturbation of the soliton by the gain, loss, filtering, dispersion and SWNT actions. In further experiments the output energy and stability enhancement of CW mode-locking can be increased by making total dispersion of the resonator slightly normal and optimizing the resonator parameters respectively.

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REFERENCES