Ultrafast modulators of light beams based on pristine or modified single-wall carbon nanotubes

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***Abstract*—In this work a procedure for formation of homogeneous thermostable composites "polyimide + single-wall carbon nanotubes" has been developed. With such composite (used as a saturable absorber) the mode-locking regime was realized in Yb fiber laser.**

Keywords—saturable absorber; mode-locking; single-wall carbon nanotubes; polyimide

Single-wall carbon nanotubes (SWNTs) working in a wide spectral range with a sub-picosecond time of relaxation of electronic excitations are widely used as ultrafast laser beam modulators in form of composites with polymers [1]. Up to now the main disadvantage of polymers was their low thermal stability. In this work we used the most thermostable polymer – polyimide- for formation the composites with SWNTs.
For polyimide matrixes the weight loss with temperature (thermogravimetry) and the heat flux (differential scanning calorimetry) have been measured. The decomposition temperature of polyimides has been estimated by both methods. The values were in the range 500-530°C depending on the sample *(Fig.1)*.

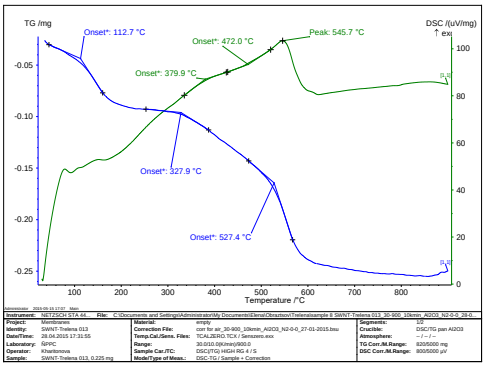

Figure 1. The data of differencial scanning calorimetry and thermogravimetry for the composite film "polyimide + CoMoCat SWNTs".

The procedure for formation of composites on the basis of SWNTs and polyimides has been developed and optimized. The aggregation degree of nanotubes was monitored by the optical absorption spectroscopy. The main problem in course of injection of polyimides into SWNTs/NMP suspension was the aggregation of nanotubes. The influence of the polymer and nanotube concentration in the solvent, the duration and power of ultrasonic treatment, the acceleration and duration of centrifugation, the temperature and drying time during the procedure of composite formation have been studied. The ytterbium fiber laser with the parameters of output radiation (λ = 1064 nm, f = 12 MHz, τ = 20 ps, Ppik~100 W) was used. The laser peak power was variable. A saturable absorber in form of SWNT/polyimide film (one layer or double-layer) was placed into the laser resonator by sandwiching between the ends of the standard FC/APC-connectors *(Fig.2)*. No degradation was observed up to peak powers of 100 W.

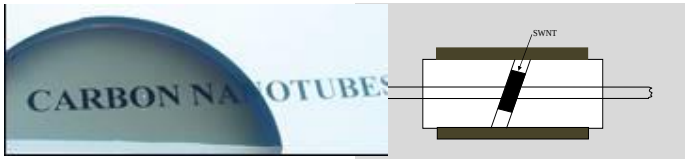

Figure 2. The saturable absorber in form of composite, sandwiched between the standard FC/APC-connectors.

The mode locking regime has been realized and confirmed by the oscillogram demonstrated a train of sub-picosecond laser pulses *(Fig.3)*.

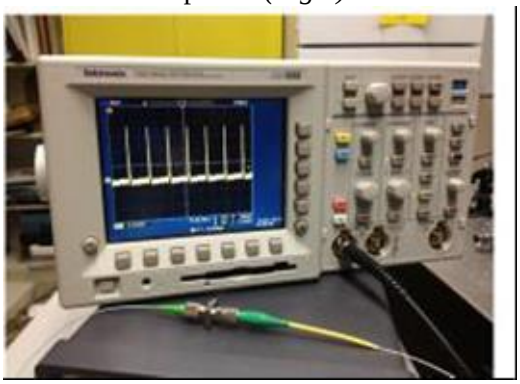

Figure 3. A train of sub-picosecond pulses, confirming a mode-locking regime realization in Yb fiber laser.

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REFERENCES

[1] Max A. Solodyankin, Elena D. Obraztsova, et al., *Optics Letters 33 (2008) 1336-1338.*