Carbon nanotubes for nonlinear optics and laser physics

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Since a first demonstration of efficiency of single-wall carbon nanotubes (SWNTs) as a saturable absorber [1], their laser applications were rapidly developed. We have joint this field with the liquid saturable absorbers based on arc SWNTs for mode locking in bulk solid state lasers (Er^{3+}(1.56 μm)[2], F_2^-:LiF(1.17 μm) [3]). According to the neccesities of fiber lasers a procedure of formation of thin polymeric films containing homogeneously distributed individual SWNTs has been developed [4]. Tailoring the nanotube media characteristics has allowed to reach a minimal pulse duration 177 fs in Er^{3+} fiber laser (1.56 μm) [5] and to realize the mode locking regime in different lasers in a whole spectral range from 1 μm to almost 2 μm (1.93 μm – in Tm fiber laser [6]). With the same films the mode locking regime has been realized in Nd:$GdVO_4$ bulk laser operating at 1.34 μm [7].

A possibility to improve the characteristics of nanotube-based media and to extend their working spectral range is discussed in this work.

For the spectral range 2-3 μm the coarse nanotubes (1.8-2.2 nm in diameter) produced by the aerosol synthesis method [8] are considered. For the visible spectral range the absorption saturation on E_{22} transition seems to be very prospective [9]. This recent discovery is both interesting for studying the fundamental optical properties of nanotubes and for technological applications – formation of non-linear optical elements for lasers (in form of films, filters and mirrors (Fig.1)) being able to work in a wide spectral range (from visible up to near IR - 3 μm).

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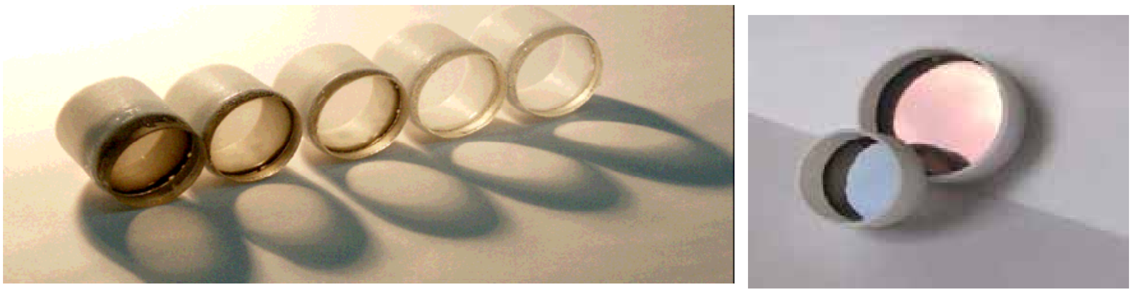

Fig. 1. The mirrors and filters covered with polymer films containing individual SWNTs.

[1] S.Y. Set, H.Yaguchi et al., Abstracts of OFC\'03 (USA), PDP44, 2003.
[2] N.N. Il'ichev, E.D. Obraztsova, S.V. Garnov et al., *Quantum Electronics* **34,** 572 (2004).
[3] N.N. Il'ichev, E.D. Obraztsova, P.P. Pashinin et al., *Quantum Electronics* **34**, 785(2004).
[4] A.I. Chernov, E.D. Obraztsova, A.S. Lobach, *Physica Status Solidi (b)* **244**, 4231 (2007).
[6] A.V. Tausenev, E.D. Obraztsova, A.S. Lobach et al., *Appl. Phys. Lett.* **92**, 171113 (2008).
[7] M.A. Solodyankin, E.D. Obraztsova, A.V. Lobach et al., *Optics Letters* **33**, 1336 (2008).
[8] A.Moisala, A.G. Nasibulin et al. , *Chemical Engineering Science* **61**, 4393 (2006).S.V. Garnov, S.A. Solokhin, E.D.Obraztsova et al., *Laser Physics Letters* **4,** 648 (2007).
[10] J. C. Travers, E. D. Obraztsova, A. S. Lobach et al., Program of Euro-CLEO 2009, CJ10.1.