STEPS Students Report

Timofei Eremin (D4)
Faculty of Physics, MSU

The aim of my research was the investigation of single walled carbon nanotubes (SWNTs) as saturable absorbers for mode-locking of solid-state laser with central wavelength 780 nm. I joined the group of Prof. Junji Yumoto.

To manufacture samples for the task, it was necessary to use nanotubes with absorption peak at 780 nm. We prepared a set of SWNTs suspensions in dichlorobenzene (DCB) using nanotubes produced by different growth techniques. We studied absorption spectra of suspensions and chose one with perceptible absorption peak near 780 nm for further investigations. Those nanotubes were synthesized with HipCO method.

The next step was to minimize bundling of nanotubes in suspension. For this aim, we varied parameters of suspension preparation (such as power and duration of ultrasonication or velocity of ultracentrifugation) and monitored absorbance of the product at 780 nm. The suspension with the best absorption was used to manufacture thin SWNT films on transparent substrates for mode-locking. There were two desirable parameters of such films: an absence of destructive interference around 780 nm and transparency around 99%. To control these parameters we varied thickness of the films and concentration of nanotubes in the films.

As the result of manufacturing step, a set of thin (~300 nm thickness) films with different transparency and broadband (200-300 nm) constructive interference at 780 nm were produced.
The next step after producing of suitable thin films was to investigate their non-linear optical properties, such as dependence of transparency on the induced power.

To complete this task, we constructed corresponding equipment. Femtosecond Ti:Sapphire laser was used as a light source. The beam was splitted to a reference channel and to a channel with sample. Beam power in both channels was measured by semiconductor photo-detectors. The output signal from photodetectors was processed by LabVIEW program, which calculated transparency of the film. The diameter of the beam spot on the sample was estimated via knife-edging technique as 200 micrometers. Taking into account maximum power on sample of 1,5 mW, it was considered to be enough to achieve saturation of thin film of nanotubes.

We measured the dependence of transparency of the film on incident power but systematical error caused by weak-nonlinear response of one of the detector did not allowed us to

make any conclusion concerning saturation power of the film. The manufactured samples are going to be studied and applied for mode-locking after avoiding of this systematical error.

During my research in the group of Prof. Junji Yumoto I gained an invaluable experience of international scientific partnership, established useful acquaintances, improved my skills and abilities in photonic and laser science and sheared my experience and knowledge on carbon nanotubes.