Polymer-free carbon nanotube saturable absorber for fiber laser ultrashort pulse generation

Yu. Gladush[1], A. Mkrtchyan[1], D. Galiakhmetova[1], A. Davletkhanov[1], D. Krasnikov, A. Nasibulin[1,2]
[1] *Skolkovo Institute of Science and Technology, Nobel str. 3, Moscow, 143026, Russia*
[2] *Aalto University, Department of Applied Physics, 00076, Aalto, Finland*
y.gladush@skoltech.ru

Passive mode-locking is a method to produce ultra-short (from picosecond to femtosecond) pulses in laser. For its implementation one should simply insert the material with saturable absorption on laser working wavelength inside the laser resonator. Single walled carbon nanotubes (SWCNT) has proven them-self as an effective saturable absorber with pronounced nonlinear optical response and wide-band operation capabilities [1]. Conventional methods of its introduction to the laser cavity imply mixing of SWCNTs with polymer to produce a composite tabled that is clamped between two connectors. This method has a drawback of a small thermal damage threshold of a hosting polymer compared to SWCNTs. Another approach is to deposit a SWCNTs from the liquid directly on the surface of the fiber – facet, side-polished surface or tapered fiber – by thermosdiffusion or any other method. In this case one have to do additional steps SWCNT solution preparation.

In our work we use polymer-free carbon nanotubes thin film as a saturable absorber for a fiber laser. We demonstrate that introduction of these film in the laser cavity can be very simple and robust and does not involve any liquid chemistry steps [2]. We compare the nonlinear optical response and thermal stability of the SWCNT films deposited on the fiber ferule and a side-polished fiber and discuss its performance in the fiber laser systems as a passive mode-lockers.

We demonstrate that SWCNT films on a side polished fiber are extremely stable towards optical damage, at the same time its nonlinear optical response is very smooth compared to that of the SWCNTs the connectors (Fig. 1). We discuss what consequences it has for the pulse generation in a mode locked regime. Finally, we address the film degradation mechanism by measuring the heating temperature of the SWCNT on the fiber ferules inside the laser cavity [3].

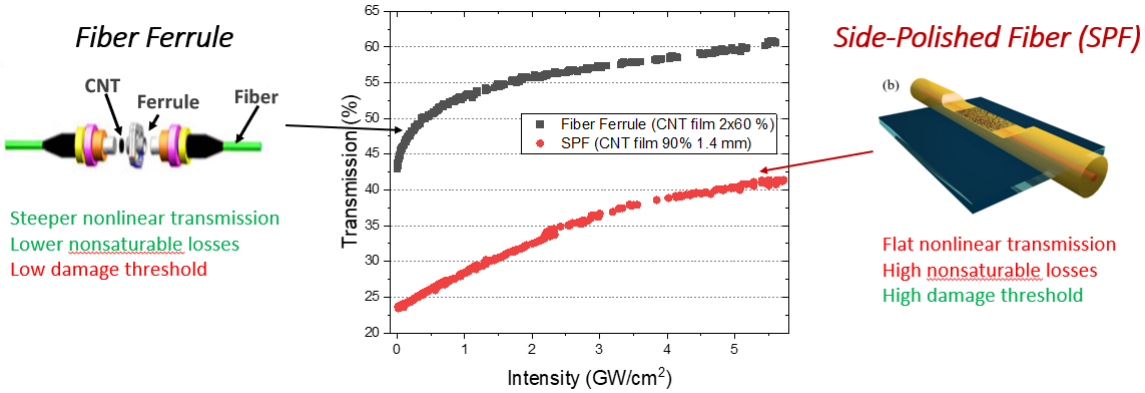

Fig. 1. Comparison of nonlinear absorption curves for carbon nanotubes deposited on the connector and a side polished fiber.

[1] M. Chernysheva et. al. Nanophotonics 6 (2017)
[2] S Kobtsev et. al., Ultrafast all-fibre laser mode-locked by polymer-free carbon nanotube film Optics Express **24**, 28768 (2016)
[3] D. Galiakhmetova et al, **Carbon,** 184, 941-948, (2021)