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Nitrogen-sealed Carbon Nanotube Saturable Absorbers

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Carbon nanotubes (CNT) have proven to be an excellent material for the modelocking of fiber lasers due to their broadband saturable absorption and fast response [1]. They have become a promising device for the implementation of novel laser configurations such as dissipative solitons for real commercial applications. For that, it is essential to address the issue of their long-term reliability under intense optical pulses before they can be exploited in widespread commercial applications. In this work, we study how CNTs degrade due to oxidation when exposed to high-intensity light and we show how by sealing the CNTs in a nitrogen gas, the damage threshold can be greatly increased. We monitor over 24 hours the performance of the CNT saturable absorbers (CNT-SA) as the passive modelocking device of an erbium-doped fiber laser with intracavity powers ranging from 5 mW to 316 mW. We observe that when the CNT are sealed in nitrogen environment, oxidation can be efficiently prevented and the laser can operate without any deterioration at intracavity powers higher than 300 mW. However, in the case where carbon nanotubes are unprotected (i.e. those directly exposed to the air in the environment), the CNT start to deteriorate at intracavity powers lower than 50 mW.

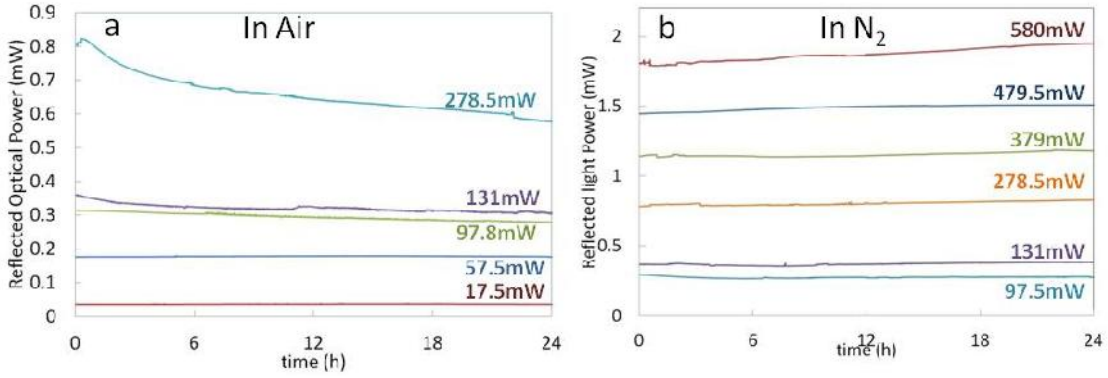

Figure 1: Reflected power from the CNT-SA over a 24 hours period with (a) the CNT in air and (b) in a nitrogen-sealed during mode-locked operation at the indicated pump powers. Decay in reflected light indicates CNT damage.

These results indicate that Nitrogen-sealing is a viable solution to increase the lifetime and stability of CNT-SAs under high optical intensities. This method will be beneficial for the long term stability of laser configurations where high pump powers (in the order of 100s of mW) are required, such as; the miniature cavity, multigigahertz fiber lasers [2] and in some cases for dissipative and pulse evolutions where the pulse energies and required pump powers are significantly higher than for standard solitons [3].

References:

[1] S.Y. Set, H. Yaguchi, Y. Tanaka and M. Jablonski, “Ultrafast Fiber Pulsed Lasers Incorporating Carbon Nanotubes,” IEEE J. Sel. Top. Quantum Electron. 10, 137 (2004).

[2] A. Martinez and S. Yamashita, "Multi-gigahertz repetition rate passively modelocked fiber lasers using carbon nanotubes," Opt. Express 19, 6155-6163 (2011).

[3] B. Xu, A. Martinez, S. Y. Set, C. S. Goh, and S. Yamashita, "Generation of Dissipative Solitons and noise-like pulse from Figure of Eight Fiber Laser," in Asia Communications and Photonics Conference, OSA Technical Digest (online) (Optical Society of America, 2012), paper ATh2A.2.