

mode locked by the CNT polymer films could be achieved when the cavity dispersion is properly managed. Moreover, the concentration of CNT may also affect the HML. For both samples, at its maximum harmonic order, the laser is stable for a few mins, this could be because the high pump power damaged the PVA film which cause degradation of the CNT sample. For lower harmonic orders, with both samples, the laser gives stable performance over hours at the laboratory condition.

The principle of harmonic mode locking is still in debate. Grudinin *et al* [5] proposed that acoustic effect plays an effective role in laser harmonic mode locking. Kutz *et al* [37] justified that the gain recovery could dominate the behavior of harmonic mode locking. The exact role of CNT in HML is still under investigation. Future work will address more on the mechanism of HML using CNT. We expect the demonstrated fiber laser can offer an effective platform for studying HML.

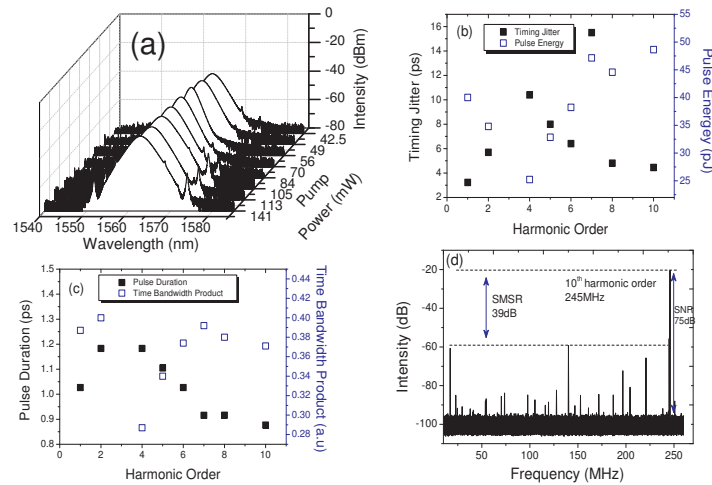


Fig. 4. C-CNT PVA mode locked EDFL (a) Evolution of optical spectrum under different pump power; (b) Measured timing jitter (black solid square) and output energy (blue empty square) against the harmonic order; (c) Measured pulse duration (black solid square) and time bandwidth product (blue empty square) over the harmonic order; (d) Measured RF spectrum of the 9th HML at 245 MHz.

5. Conclusion

In conclusion, we have experimental investigated the centrifugated and filtrated CoMoCAT CNT PVA thin film saturable absorber for HML in an EDFL. The demonstrated EDFL outputs chirped soliton pulses with ~ 1 ps pulse duration for both types of CNT PVA films. The EDFL shows a maximum of 10th harmonic order operation at 245 MHz with the output power of ~ 12 mW with the C-CNT PVA saturable absorber which is higher than the previous results using a CNT polymer film mode locker. The timing jitter of the EDFL with both CNT PVA saturable absorbers is measured to be lower than 10 ps. The EDFL also shows higher SMSR ratio than some previous results. Although the absorption for both CNT PVA samples is different, it does not make a huge difference on their performance in HML of EDFL.