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## Zinc-oxide nanoparticle-based saturable absorber deposited by simple evaporation technique for Q-switched fiber laser

By: [Husin, SAS](#) (Husin, Syarifah Aloyah Syed)<sup>[1]</sup>; [Muhammad, FD](#) (Muhammad, Farah Diana)<sup>[1]</sup>; [Abdullah, CAC](#) (Abdullah, Che Azurahaman Che)<sup>[1]</sup>; [Ribut, SH](#) (Ribut, Siti Huzaimah)<sup>[1]</sup>; [Zulkifli, MZ](#) (Zulkifli, Mohd Zamani)<sup>[2,3]</sup>; [Mandi, MA](#) (Mandi, Mohd Adzir)<sup>[4]</sup>

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### Abstract

A Q-switched erbium-doped fiber laser (EDFL) incorporating zinc-oxide (ZnO) nanoparticles-based saturable absorber (SA) is proposed and demonstrated. To form the SA, the ZnO nanoparticles, which are originally in the powder form, are first dissolved in ethanol and subsequently deposited onto the surface of fiber ferrule by using the adhesion effect with the evaporation technique. By integrating the ZnO nanoparticle-based SA into a laser cavity of an EDFL, a self-started and stable Q-switching is achieved at a low threshold power of 20.24 mW. As the pump power is increased, the pulse repetition rate is tunable from 10.34 kHz to 25.59 kHz while pulse duration decreases from 21.39 μs to 3.65 μs. Additionally, this Q-switched laser has a maximum energy per pulse of 19.34 nJ and an average output power of 0.46 mW. These results indicate the feasibility and functionality of the ZnO nanoparticles-based SA for Q-switched generation, which offers the flexibility and easy integration of the SA into a ring laser cavity.

### Keywords

**Author Keywords:** zinc oxide; saturable absorber; Q-switched; fiber laser  
**KeyWords Plus:** ZNO; FILM

### Author Information

**Reprint Address:** Muhammad, FD (reprint author)

+ Univ Putra Malaysia, Fac Sci, Dept Phys, Upm Serdang 43400, Selangor, Malaysia.

### Addresses:

- + [ 1 ] Univ Putra Malaysia, Fac Sci, Dept Phys, Upm Serdang 43400, Selangor, Malaysia
- + [ 2 ] Univ Malaya, Photon Res Ctr, Dept Phys, Kuala Lumpur 50603, Malaysia
- + [ 3 ] Int Islamic Univ Malaysia, Kulliyah Sci, Jalan Sultan Ahmad Shah, Kuantan 25200, Pahang, Malaysia
- + [ 4 ] Univ Putra Malaysia, Fac Engr, Wireless & Photon Networks Res Ctr, Upm Serdang 43400, Selangor, Malaysia

**E-mail Addresses:** [farandiana@upm.edu.my](mailto:farandiana@upm.edu.my)

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## Cited References: 52

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1. **Tunable Q-switched fiber laser using zinc oxide nanoparticles as a saturable absorber** Times Cited: 20  
 By: Ahmad, H.; Lee, C. S. J.; Ismail, M. A.; et al.  
 APPLIED OPTICS Volume: 55 Issue: 16 Pages: 4277-4281 Published: JUN 1 2016
2. **C-Band Q-Switched Fiber Laser Using Titanium Dioxide (TiO<sub>2</sub>) As Saturable Absorber** Times Cited: 45  
 By: Ahmad, H.; Reduan, S. A.; Ali, Zainal Abidin; et al.  
 IEEE PHOTONICS JOURNAL Volume: 8 Issue: 1 Article Number: 1500107 Published: FEB 2016
3. **Graphene-Oxide-Based Saturable Absorber for All-Fiber Q-Switching With a Simple Optical Deposition Technique** Times Cited: 28  
 By: Ahmad, H.; Muhammad, F. D.; Zulkifli, M. Z.; et al.  
 IEEE PHOTONICS JOURNAL Volume: 4 Issue: 6 Pages: 2205-2213 Published: DEC 2012
4. **Q-switched ytterbium-doped fiber laser with zinc oxide based saturable absorber** Times Cited: 12  
 By: Ahmad, H.; Salim, M. A. M.; Ismail, M. F.; et al.  
 LASER PHYSICS Volume: 26 Issue: 11 Article Number: 115107 Published: NOV 2016
5. **Zinc oxide (ZnO) nanoparticles as saturable absorber in passively Q-switched fiber laser** Times Cited: 42  
 By: Ahmad, H.; Lee, C. S. J.; Ismail, M. A.; et al.  
 OPTICS COMMUNICATIONS Volume: 381 Pages: 72-76 Published: DEC 15 2016
6. **Infrared dielectric functions and phonon modes of high-quality ZnO films** Times Cited: 493  
 By: Ashkenov, N.; Mbenkum, BN; Bundesmann, C; et al.  
 JOURNAL OF APPLIED PHYSICS Volume: 93 Issue: 1 Pages: 126-133 Published: JAN 1 2003
7. **Zinc Oxide-Based Q-Switched Erbium-Doped Fiber Laser** Times Cited: 18  
 By: Aziz, N. A.; Latiff, A. A.; Lokman, M. Q.; et al.  
 CHINESE PHYSICS LETTERS Volume: 34 Issue: 4 Article Number: 044202 Published: MAR 2017
8. **Optically pumped lasing of ZnO at room temperature** Times Cited: 2,076  
 By: Bagnall, DM; Chen, YF; Zhu, Z; et al.  
 APPLIED PHYSICS LETTERS Volume: 70 Issue: 17 Pages: 2230-2232 Published: APR 28 1997
9. **Graphene photonics and optoelectronics** Times Cited: 4,592  
 By: Bonaccorso, F.; Sun, Z.; Hasan, T.; et al.  
 NATURE PHOTONICS Volume: 4 Issue: 9 Pages: 611-622 Published: SEP 2010
10. **Fast and Broadband Photoresponse of Few-Layer Black Phosphorus Field-Effect Transistors** Times Cited: 890  
 By: Buscema, Michele; Groenendijk, Dirk J.; Blanter, Sofya I.; et al.  
 NANO LETTERS Volume: 14 Issue: 6 Pages: 3347-3352 Published: JUN 2014
11. **VISIBLE RETINAL LESIONS FROM ULTRASHORT LASER-PULSES IN THE PRIMATE EYE** Times Cited: 56  
 By: CAIN, CP; TOTH, CA; DICARLO, CD; et al.  
 INVESTIGATIVE OPHTHALMOLOGY & VISUAL SCIENCE Volume: 36 Issue: 5 Pages: 879-888 Published: APR 1995
12. **LASER-PRODUCED PLASMAS IN MEDICINE** Times Cited: 27  
 By: GITOMER, SJ; JONES, RD  
 IEEE TRANSACTIONS ON PLASMA SCIENCE Volume: 19 Issue: 6 Pages: 1209-1219 Published: DEC 1991
13. **Experimental investigation of ultrashort pulse laser-induced breakdown thresholds in aqueous media** Times Cited: 81  
 By: Hammer, DX; Thomas, RJ; Noojin, GD; et al.  
 IEEE JOURNAL OF QUANTUM ELECTRONICS Volume: 32 Issue: 4 Pages: 670-678 Published: APR 1996
14. **Liquid exfoliation of solvent-stabilized few-layer black phosphorus for applications beyond electronics** Times Cited: 432  
 By: Hanlon, Damien; Backes, Claudia; Doherty, Evie; et al.  
 NATURE COMMUNICATIONS Volume: 6 Article Number: 8563 Published: OCT 2015
15. **A topological Dirac insulator in a quantum spin Hall phase** Times Cited: 2,120  
 By: Hsieh, D.; Qian, D.; Wray, L.; et al.  
 NATURE Volume: 452 Issue: 7190 Pages: 970-U5 Published: APR 24 2008
16. **Widely-tunable, passively Q-switched erbium-doped fiber laser with few-layer MoS<sub>2</sub> saturable absorber** Times Cited: 135  
 By: Huang, Yizhong; Luo, Zhengqian; Li, Yingyue; et al.  
 OPTICS EXPRESS Volume: 22 Issue: 21 Pages: 25258-25266 Published: OCT 20 2014
17. **Zinc Oxide Bulk, Thin Films and Nanostructures: Processing, Properties and Applications** Times Cited: 578  
 Edited by: Jagadish, C; Pearton, SJ  
 ZINC OXIDE BULK, THIN FILMS AND NANOSTRUCTURES: PROCESSING, PROPERTIES AND APPLICATIONS Pages: 1-589 Published: 2006  
 Publisher: ELSEVIER SCIENCE BV, SARA BURGERHARTSTRAAT 25, PO BOX 211, 1000 AE AMSTERDAM, NETHERLANDS

18. **Fundamentals of zinc oxide as a semiconductor** Times Cited: 1,997  
By: Janotti, Anderson; Van de Walle, Chris G.  
REPORTS ON PROGRESS IN PHYSICS Volume: 72 Issue: 12 Article Number: 126501 Published: DEC 2009
19. **Ultrafast carrier dynamics in single ZnO nanowire and nanoribbon lasers** Times Cited: 280  
By: Johnson, JC; Knutsen, KP; Yan, HQ; et al.  
NANO LETTERS Volume: 4 Issue: 2 Pages: 197-204 Published: FEB 2004
20. **Corneal refractive surgery with femtosecond lasers** Times Cited: 266  
By: Juhasz, T; Frieder, H; Kurtz, RM; et al.  
IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS Volume: 5 Issue: 4 Pages: 902-910 Published: JUL-AUG 1999
21. **Recent developments in compact ultrafast lasers** Times Cited: 1,135  
By: Keller, U  
NATURE Volume: 424 Issue: 6950 Pages: 831-838 Published: AUG 14 2003
22. **Magnesium oxide (MgO) thin film as saturable absorber for passively mode locked erbium-doped fiber laser** Times Cited: 2  
By: Khaleel, Wurood Abdulkhaleq; Sadeq, Sinan Abdulhameed; Alani, I. A. M.; et al.  
OPTICS AND LASER TECHNOLOGY Volume: 115 Pages: 331-336 Published: JUL 2019
23. **Raman spectroscopic study of the ZnO nanostructures** Times Cited: 33  
By: Khan, A.  
J. Pak. Mater Soc. Volume: 4 Issue: 1 Pages: 5-9 Published: 2010
24. **Mechanically deposited tungsten disulfide saturable absorber for low-threshold Q-switched erbium-doped fiber laser** Times Cited: 4  
By: Lau, K. Y.; Latif, A. A.; Abu Bakar, M. H.; et al.  
APPLIED PHYSICS B-LASERS AND OPTICS Volume: 123 Issue: 8 Article Number: 221 Published: AUG 2017
25. **Passively Q-Switched Erbium-Doped Fiber Laser Based on Few-Layer MoS<sub>2</sub> Saturable Absorber** Times Cited: 75  
By: Li, Heping; Xia, Handing; Lan, Changyong; et al.  
IEEE PHOTONICS TECHNOLOGY LETTERS Volume: 27 Issue: 1 Pages: 69-72 Published: JAN 1 2015
26. **Two-photon resonance assisted huge nonlinear refraction and absorption in ZnO thin films** Times Cited: 70  
By: Lin, JH; Chen, YJ; Lin, HY; et al.  
JOURNAL OF APPLIED PHYSICS Volume: 97 Issue: 3 Article Number: 033526 Published: FEB 1 2005
27. **Non-thermal ablation of neural tissue with femtosecond laser pulses** Times Cited: 165  
By: Loesel, FH; Fischer, JP; Gotz, MH; et al.  
APPLIED PHYSICS B-LASERS AND OPTICS Volume: 66 Issue: 1 Pages: 121-128 Published: JAN 1998
28. **BAND-GAPS, CRYSTAL-FIELD SPLITTING, SPIN-ORBIT-COUPLING, AND EXCITON BINDING-ENERGIES IN ZNO UNDER HYDROSTATIC-PRESSURE** Times Cited: 364  
By: MANG, A; REIMANN, K; RUBENACKE, S  
SOLID STATE COMMUNICATIONS Volume: 94 Issue: 4 Pages: 251-254 Published: APR 1995
29. **Nanotube and graphene saturable absorbers for fibre lasers** Times Cited: 412  
By: Martinez, Amos; Sun, Zhipei  
NATURE PHOTONICS Volume: 7 Issue: 11 Pages: 842-845 Published: NOV 2013
30. Title: [not available] Times Cited: 87  
By: Matte, H. S. S. Ramakrishna; Gomathi, A.; Manna, A. K.; et al.  
Angew. Chem. Volume: 122 Pages: 4153-4156 Published: 2010  
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