

UNIVERSITI TEKNOLOGI MARA

**NIOBIUM AND VANADIUM
ALUMINIUM CARBIDE
SATURABLE ABSORBERS
FOR 1.5 MICRON
PULSED FIBER LASER**

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Engineering
(Electrical Engineering)

Faculty of Electrical Engineering

June 2023

ABSTRACT

Q-switched and mode-locked fiber lasers have attracted tremendous research attentions owing to their excellent characteristics including high beam quality, cost effective design, alignment-free and compact structure. A saturable absorber (SA) is essential in a fiber laser cavity for the passive initiation of pulses. As a result, the researchers have always been interested in SAs that can create pulse lasers with great performance and strong optical stability. This thesis aims to explore the potential of two MAX phase materials: V₂A₁C, and M₂A₁C for use as a SA for both Q-switched and mode-locked pulse generation in the 1.5- μ m region. In this work, two types of SA are prepared based on film approach. This SA is inserted in a fiber laser cavity to achieve all-fiber pulsed lasers in a low-cost, simple, and convenient process. At first, a stable and self-starting Q-switched pulses were obtained by integrating V₂A₁C based SA in an EDFL cavity. It operated at 1559 nm and the highest repetition rate, minimum pulse width and the maximum single pulse energy of 53.55 kHz, 2.54 μ s and 57.14 nJ were recorded, respectively at pump power of 71.5 mW. The generation of soliton pulses has also been demonstrated by utilizing V₂A₁C film, which has a saturable absorption of 27 % as SA in an EDFL cavity with a length of 206 m. The mode locked EDFL operated at repetition frequency of 969 kHz with a pulse width of 3.96 ps within a pump power of 77 to 228 mW. The laser achieved the maximum pulse energy and peak power of 15.28 nJ and 3.4 kW, respectively. On the other hand, M₂A₁C based SA was also successfully used to demonstrate both Q-switching and mode-locking operations in an EDFL cavity. The Q-switched EDFL operated at 1531 nm with a minimum pulse width of 3.82 μ s, maximum repetition rate of 58.21 kHz and the highest pulse energy of 42.26 nJ. In an extended EDFL cavity, a dissipative soliton pulse train was also realized. It generated output spectrum with a rectangular shape with two peaks centered at wavelengths of 1528.56 nm and 1532.16 nm. The mode-locked laser operated at 1 MHz repetition rate and 6.4 ps pulse width and exhibited the maximum pulse energy of 7.43 nJ, maximum average output power of 7.2 mW and maximum peak power of 1.03 kW at 175.87 mW pump power. These results reveal that both V₂A₁C and M₂A₁C MAX phase materials can be used as a Q-switcher or mode-locker and thus they have a great potential for use in other photonics applications. The MAX phase material is expected to become a strong competitor especially for implementation as practical SA due to its advantages including excellent antioxidant, high stability, and ease on fabrication. Q-switched and mode-locked pulsed lasers in the 1.5- μ m regime are essential for applications such as material processing, remote sensing, medicine, telecommunications etc.

ACKNOWLEDGEMENT

First and foremost, I thank Allah SWT for the love, blessings, mercies, and opportunity to complete my thesis.

I would like to express my deep and sincere gratitude to my research supervisors, Dr. Ami Munira Markom and Assoc. Prof. Ir. Dr. Zulzilawati Jusoh, who deserve my gratitude and appreciation in guiding, mentoring, and assisting me with the completion of this thesis as well as my laboratory work. I am also grateful to Prof. Ir. Dr. Sulaiman Wadi Harun, my external supervisor, for his encouragement, advise, and motivation during this amazing and gratifying Master journey. Without their help and instructions, this thesis would not have turned out the way it did.

I'd like to express my gratitude to the Photonics Engineering Laboratory at the University of Malaya for the equipment and apparatus used in this study. An appreciation should also be given to my colleague's laboratory members at the University of Malaya, who were always willing to assist me when I needed it. Dr. Farhana, Dr. Haziq, Dr. Suziana and many others who are among my favourite laboratory members. I am grateful for all your contributions.

Last but not least, my ultimate inspiration comes from my best friends, my soul, the persons from whom I received my name as well as my life's blood. My parents never gave me any idea that I couldn't do whatever I wanted to do or be whoever I wanted to be. They both filled our house with love and fun and books and knowledge, unflagging in their efforts to give me role models. As they guided me through these incredible years, I don't know if they ever realized how truly grateful I am. For my Ibu,
and my late Abah, , this is
for you.

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