UNIVERSITI TEKNOLOGI MARA

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

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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: V2AIC, and M>2A1C for use as a SA for both Q-switched and mode-locked pulse generation in the 1.5-um 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 V2AIC 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 us 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 V2AIC 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, M>2A1C 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 us, 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 V2AIC and M>2A1C 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-um regime are essential for applications such as material processing, remote sensing, medicine, telecommunications etc.

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