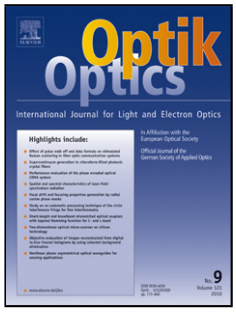

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Thermal behavior of micro-channel cooled thin-slab Fe:ZnSe lasers

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Abstract

Thermal effect is a key problem to obtain high average power output from the Fe:ZnSe crystal. Main parameters of micro-channel structure heat sink, such as channel depth, width and duty cycle are designed and optimized to improve the dissipation capability. And on these basis, a thin-slab and composite Fe:ZnSe model is constructed and the temperature distribution of the Fe:ZnSe is analyzed and discussed.

Keywords: thermal analysis; micro-channel; thin slab; Fe:ZnSe

1. Introduction

Mid-infrared lasers have been a research hot spot in the international laser field because of its wide and important applications in the military, medical and scientific [1-4]. Compared with other mid-infrared laser technology, the technology route that transition metal ion doped II-IV sulfide pumped by laser diode has been considered the most promising technology road to obtain high power and high beam quality output because of the advantages of compact structure, flexible wavelength diversity, relatively low price[5-10]. Among them, the Fe:ZnSe is one of the most effective laser media to achieve high efficiency, wide bandwidth, tunable 3.5-5.5μm laser output because of the excellent physical properties and spectral characteristics.

In 1999, for the first time, mid-infrared laser with the maximum pulse energy of 12μJ and the tunable range of 3.98-4.54μm was obtained from the Fe:ZnSe pumped by 2.7μm Er:YAG laser at low temperature [7]. Mirov and his group have engaged in mid-infrared lasers research for a long time and obtained many achievements in the field of Fe:ZnSe. In 2015, a Fe:ZnSe lasers with single pulse energy of 0.35J, repetition rate of 100Hz and pulse width of 150μs was reported by Mirov and Martyshkin [8-13]. At the same year, Lebedev group reported an Fe:ZnSe laser with output energy of 4.9J and center wavelength of 4.1μm at 85K. But at room temperature, the output energy decreased to 53mJ. At 2016, they have raised the output energy to 10.6J at low temperature [14-17].

To sum up, benefit from the development of 2-3μm lasers and the laser material, many research results about the Fe:ZnSe have been reported. But in order to meet the needs of practical engineering applications, more detailed research is necessary for higher power and beam quality. The thermal management is one of key problem for high power output, especially for Fe:ZnSe, which optical and thermodynamic