Crystalline-orientation Selected Linearly Polarized Yb:YAG Microchip Laser

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We present the experimental demonstration of a linearly polarized continuous-wave microchip laser based on cubic Yb:YAG crystal selected by the crystalline orientations in the (111) plane when the light propagates along the [111] direction. The effect of pump power induced birefringence and depolarization on the crystalline orientation selected linearly polarized states of continuous-wave Yb:YAG microchip lasers was addressed.

The laser-diode crystalline-orientation selected linearly polarized Yb:YAG microchip laser experimental setup was described in elsewhere[1]. 1-mm-thick, plane-parallel [111]-cut Yb:YAG crystal plates (C_{Yb} = 10, 15 and 20 at.%) were used as gain media. The polarization states of these microchip lasers were determined by using a Glan-Thomson prism and a power meter. Figure 1 shows the normalized transmission of Yb:YAG microchip lasers after polarizer as a function of polarizer angle for different rotation angles of Yb:YAG crystals along the [111] direction when the absorbed pump power intensity was 20 kW/cm². Six orientations in the (111) plane exhibit “perfect” linear polarization (extinction ratio > 100) of Yb:YAG microchip lasers, as shown in Fig. 1(a). When the rotating angle was set between any two of these six positions, although Yb:YAG microchip lasers still exhibit the linear polarization in some degrees, the variation of the output power does not show clearly perfect linear polarization, some examples are shown in Fig. 1(b). Figure 2 shows the output power and the ratio of the horizontal polarized component to the total output power of six crystalline-orientation selected polarized lasers as a function of the absorbed pump power. The laser polarization states of Yb:YAG microchip lasers were strongly affected by the absorbed pump power, the laser exhibits a linear polarization state at low absorbed pump power, the extinction ratio of linear polarization decreases with the absorbed pump power intensity (between 30 and 45 kW/cm²). The laser oscillates with random polarization states at higher pump power intensity (>45 kW/cm²). Crystalline-orientation selected polarization states of Yb:YAG microchip lasers at low pump power levels are caused by the three-fold local symmetry of dodecahedral coordinated Yb³⁺ ions in cubic YAG crystal[2, 3]. The strong depolarization at high pump power affect the polarization states of Yb:YAG microchip lasers and lasers tend to oscillate at random polarization states[4].

In summary, perfect linear polarization was observed at six crystalline orientations of Yb:YAG crystal at low pump power range (< 45 kW/cm²). The extinction ratio of the linear polarization decreases with pump power intensity. Polarization states of Yb:YAG microchip lasers were attributed to the anisotropic symmetry of Yb:YAG. The strong thermal birefringence and depolarization at high pump power level limit the linear polarization of Yb:YAG microchip lasers and the lasers oscillate at random polarization states.

References