
Dan Wang, Lixin Tong, Tangjian Zhou, Juntao Wang, Hao Hu, Qingsong Gao, Chun Tang
The Key Laboratory of Science and Technology on High Energy Laser, China Academy of Engineering Physics, Mianyang, P.R.China

Abstract—The relationship between extracting powers and spectrum widths of input beams in Nd:YAG amplifiers is obtained both in theory and experiments. A theoretical model of laser amplifier is established by considering spectral homogeneous broadening, gain saturation and amplified spontaneous emission. The results in theory and experiments show the difference of extracting powers under two spectrum widths exists the extreme value.

Keywords—spectrum widths; Nd:YAG; gain saturation; small-signal gain coefficients; spectral homogeneous broadening

I. SUMMERY

For the low concentration doped Nd:YAG crystal, the fluorescence spectrum near 1064 nm is narrow and sharp. Thus the extracting powers of Nd:YAG amplifiers are significantly affected by the spectrum widths of input laser. In this paper, the relationship between extracting powers and spectrum widths is quantitatively investigated.

Firstly a Nd:YAG amplifier model that bases on the spectra is established, in which the spectral homogeneous broadening, the gain saturation and amplified spontaneous emission (ASE) are considered. The computational results reveal that the narrower spectrum width of input beam obtains higher extracting powers than the wider one under same input and pump power. For the two spectrum widths of input beams, the difference on the extracting powers also depends on the small-signal gain coefficients ($g_0$), and the relationship between them is Gaussian-like curve according to the data-fitting. The positions of extreme values in the curves are also related with the input powers due to the gain saturation.

Secondly the experiments of Nd:YAG laser amplifier are carried out. The pump parameters of the amplifiers and the input beam powers, intensity profile, center wavelength (1064.4 nm) are keep the same, the spectrum widths of input lasers are chosen as 0.02 nm and 0.4 nm. The experimental results show that the difference of extracting powers under the two spectrum widths is less than 8% in different pump powers. The extreme value appears at 0.05 cm$^{-1}$ of $g_0$, when the input power is 27W. With the input power increasing, the positions of extreme values move to the larger $g_0$ value.

In addition, the experimental results are compared with the theoretical results, which prove the theoretical analysis and predictions.

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