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Optimization of a DPAL system by adjusting cell structural parameters and cell temperatures

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In recent years, a diode-pumped alkali laser (DPAL) has provided the significant promise for high-powered applications. A series of models have been established to analyze the DPAL's kinetic process and most of them were based on the algorithms in which only the ideal 3-level system was considered. However, alkalis are the most easily ionized atomic species, especially for Rb and Cs. under the condition of strong pumping the electrons will be excited to the higher levels, $6^2D_{5/2,3/2}$ and $8^2S_{1/2}$, by energy pooling collisions. Then, further ionization processes including photo-ionization and Penning ionization will occur on the $6^2D_{5/2,3/2}$ and $8^2S_{1/2}$ levels resulting in decrease of the density of neutral atoms. To examine the kinetic processes of the gas-state media, a mathematical model is developed taking into account the process of normal transition, energy pooling, and ionization. The procedures of heat transfer and laser kinetics were combined together in our theoretical model. We systemically investigated the influences of the temperature, cell length, and cell radius on the output features of a DPAL. By optimizing these key factors, the optical-to-optical conversion efficiency of a DPAL can be evidently improved. Further, the calculated results indicate that the influence of energy pooling and ionization can be obviously suppressed with the optimal parameters. In the case of high pump power, 1000 W, the influence of energy pooling and ionization on output power decreases from 6.02% to 1.04% and the optical-to-optical efficiency increases from 16.5% to 51.5% after optimizing. Basically, some conclusions we obtained here can be extended to any other kinds of end-pumped laser configurations.

Biography

Guofei An received his Bachelor's degree in Applied Physics at Northwest Polytechnical University and has completed his PhD in Condensed Matter Physics from Northwest Polytechnical University in China at 2014. After obtaining his PhD, he worked as a research fellow of Laser Engineering in the Southwest Institute of Technical Physics. His scientific interests are in the area of laser kinetics, quantum electronics, nano-laser, and heat transfer in laser cavity. He has published more than 30 papers in scientific journals since 2010. Currently, he is mainly engaged in the research on the diode-pumped alkali vapor laser including both theoretical modeling and experiment.

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