

Article Overview

A diode-pumped alkali laser (DPAL) is a high-efficiency gas laser using alkali metal vapor as the gain medium, pumped by laser diodes, capable of high power and excellent beam quality.

Operating Principle

DPALs are optically pumped gas lasers where a laser diode excites alkali metal atoms--commonly potassium (K), rubidium (Rb), or cesium (Cs)--from the ground state to an upper fine-structure level via the D2 absorption transition. Collisional mixing with buffer gases like helium transfers the population to the lower fine-structure level, which serves as the upper laser level. Stimulated emission then occurs on the D1 transition, returning atoms to the ground state, producing coherent light with high quantum efficiency and low thermal loading .

Key Features

- o High efficiency: DPALs have a low quantum defect, minimizing wasted energy as heat .
- o Excellent beam quality: The gaseous medium allows diffraction-limited output, even at high powers .
- o Scalability: Flowing buffer gas removes heat, enabling high average power operation .
- o Wavelength flexibility: Alkali metals provide emission in the near-infrared, e.g., Rb DPALs at 795 nm, advantageous for propagation and focusing .

Pulsed Operation

Pulsed DPALs are of particular interest for LiDAR, free-space optical communication, and precision material processing. Techniques include pump modulation, intracavity modulation, cavity dumping, and mode-locking. Mode-locked DPALs can generate nanosecond-scale pulses with structured temporal output, enabling high peak power and precise temporal control .

Applications

- o Directed energy weapons: High-power, low size-weight-and-power (SWaP) DPALs are being developed for UAV-based missile defense, capable of delivering lethal energy over long distances .
- o LiDAR and space domain awareness: DPALs provide ultra-narrow linewidth, mode-locked pulses for high-resolution, time-of-flight LiDAR systems, enabling detection of small debris and precise spatial mapping .
- o Industrial and scientific uses: Potential applications include material processing and laboratory research requiring high-power, tunable near-infrared lasers .

Diode-pumped alkaline laser

Current Status and Development

DPAL technology is still evolving, with ongoing research focusing on:

- o Power scaling through MOPA architectures and flowing-gas gain cells .
- o Mode-locked and burst-mode pulsed operation for structured temporal outputs .
- o Spectral extension via nonlinear frequency conversion .
- o Compact, robust designs suitable for field deployment in defense and aerospace applications . DPALs combine the scalability of chemical lasers with the efficiency and electrical pumping of diode lasers, making them promising candidates for high-power, high-quality laser applications in both military and civilian domains .

Krupke expects diode-pumped alkali lasers should scale to well over 100 kW with a single aperture delivering a high

In this review we present the analysis of optically pumped alkali lasers research and development from their first

The historical aspect, present status, and future prospects of diode-pumped alkali lasers (DPAL) are discussed. DPAL is a relatively

Recent developments in high-power diode laser technologies have enabled significant progress in the field of diode

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A diode-pumped alkali laser (DPAL) is an optically pumped, highly efficient, extremely high-power gas laser. It has been scaled up to

A Low-Pressure diode pumped Alkali Laser (LPAL) can provide a diffraction-limited high-power beam with

This patented system spectrally locks the pump diode arrays precisely to the narrow alkali absorption line, delivering high-brightness

The concept and physical principles of diode pumped resonance alkali lasers are outlined. A brief history of stimulated

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Diode-pumped alkaline laser

A tunable diode laser absorption spectroscopy device was developed to study atmospheric propagation for emerging

The Diode-Pumped Alkali Laser (DPAL) system is an R&D effort funded by the Missile Defense Agency (MDA) underway at

Diode-pumped alkali vapor lasers (DPALs) are a class of optically pumped gas lasers in

General Atomics has been engaged in the development of diode pumped alkali vapor lasers. We have been

Diode-pumped alkali vapor lasers (DPALs) offer high quantum efficiency, low thermal

In diode pumped alkali lasers (DPALs), lasing action occurs on the resonant lines of alkali atoms following pumping by broadband

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