A compact external cavity laser diode coupled tapered amplifier system for isotope separation and analysis

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An external cavity diode laser coupled tapered amplifier system was constructed on a single heatsink/baseplate to allow for easy portability and compact, laboratory bench-top scale usage. Description of the design and construction, as well as pertinent characteristics is provided. The system is intended for isotope selective purposes, in particular, the quantification and analysis of Ca-41 for nuclear decommissioning, but the system may be applied to any appropriate isotope.

Keywords: laser resonance excitation, external cavity laser diode, tapered amplifier, miniaturization, portability

1. Introduction

For atomic spectroscopy and isotope analysis related experiments where laser irradiationis required, it is popular to use diode lasers (in the form of external cavity diode lasers: ECDLs), due to their relative affordability, ease of setup and high frequency tunability. However, their main drawback is in their comparatively low lasing intensities. In applications where a high lasing power is required, such as for the low cross-section transition in a resonance ionization scheme, often less-readily tunable lasers are used. Semiconductor devices known as tapered amplifiers (TPAs) can be used to amplify a seed laser diode beam while preserving its frequency tunability (see, e.g. Ref. [1]), providing an advantage over other laser systems. Here we describe the construction of an ECDL coupled with a TPA with both mounting blocks [2] and intermediary optics sited on a single baseplate, as opposed to separate enclosures.

2. Methods

In a first design iteration wherein the ECDL and TPA mounts were separately placed on individual heatsinks, it was found that when the system was operated at the power output required for Ca resonance ionization experiments (~250 mW), the ECDL seed beam coupling rapidly degraded, causing the power output to decay rapidly to non-useful levels. It was found that the individual heat sink was not capable of absorbing the heat produced by the TPA, and the subsequent thermal expansion dislocated the ECDL coupling. The solution was to place both the ECDL and TPA on a single heatsink base, thermally capable of mitigating the heat flux from the TPA. Alongside this, methods in coupling the ECDL to the TPA are fully discussed, as well as thermal characterization through MATLAB simulation and direct measurement.

3. Conclusion

An all-on-one baseplate ECDL seeded TPA laser system is constructed; it was found that control of the thermal conditions is absolutely essential for maintaining seed beam coupling and hence stable operation for experimentation, therefore a full design justification and characterization is provided here. Design motivations included portability for easy transport to collaborating laboratories, as well as miniaturization for laboratories where space is a premium, with possible application to mobile systems. The unit provides stable, high-power output confirmed to be suitable for isotope selective resonance ionization experiments for radioisotope analysis (LIBS for nuclear material analysis, isotope selective separation procedures etc.).

References

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