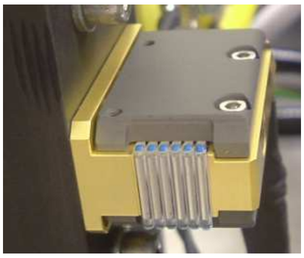
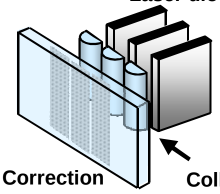
Research Project

Fabrication of Novel Micro-optics for Applications in Manufacturing

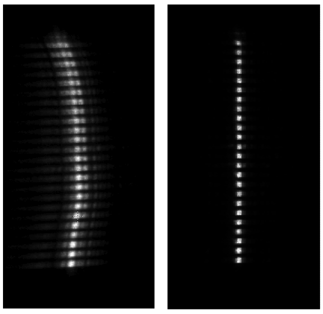
HERIOT WATT UNIVERSITY



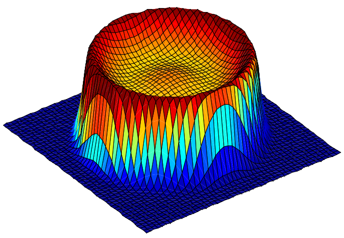
Commercial HPDL stack



HPDL beam correction



Before correction *After correction*



Optical surface for flat-top generator

Commercial high-power diode laser

Rationale

High power diode lasers (HPDL) are widely used in a range of applications including industrial materials processing and as pump sources for high power solid state and fibre lasers. Such applications exploit the intrinsic HPDL advantages of very high electrical-to-optical conversion efficiency, small size, convenience in usage and reliability. However, their use in many key applications is limited by the poor optical quality of the beams from diode laser bars and stacks. Recent research at HWU has demonstrated in principle the use of a new technique for achieving HPDL beam correction. Significant improvements in beam quality are achieved through the design and manufacture of a custom micro-optic silica correction plate for each HPDL source, fabricated in-house by a novel laser micro-machining technique. This manufacturing process can also be used to fabricate custom optical elements that can shape the beam profile at the workpiece, and correct for aberrations in relay optics.

HPDL sources with high brightness and tailored intensity profiles offer the prospect of significant capital equipment cost reduction in laser material processing, as well as higher performance diode-pumped solid state lasers. The programme of applications work has been conceived with, and will be carried out in partnership with our industrial collaborators BAE Systems and Airbus UK with the primary goal of realising sources for improved performance and reduced cost in laser material processing.

Research Aims

In this project, the HPDL characterisation process and the optical manufacturing process will both be developed to provide refractive optics that give HPDL correction with performance as close as possible to theoretical limits, combined with optical functionality for beamforming and aberration correction. The functionality and performance of these will be demonstrated in a working breadboard system. The source and optics will then be integrated into fully-packaged HPDL modules, and demonstrated in a set of material processing trials.

Research Objectives

The particular objectives are to:

- Develop a process for HPDL fast-axis beam correction that approaches the fundamental limits imposed by source coherence and primary collimation,
- Develop and demonstrate a process for design and fabrication of functional beamforming optics that provide application-specific beam intensity profiles
- Achieve increased source brightness by aberration correction in relay optics
- Evaluate the performance of beam correction, beamforming, and aberration correction in a breadboard system
- Develop compact opto-mechanical HPDL modules incorporating diode stacks, beam correction and beamforming optics
- Deploy the HPDL modules in trials for a series of industry-derived materials processing tasks to be conducted in partnership with industrial collaborators.

Research Tasks

- Definition of HPDL characteristics required for specified material processing applications
- Stack characterisation, and manufacture and beam correction phaseplates
- Design and manufacture of beam formatting and lens aberration correction phaseplates
- Construction of a working 'breadboard' system producing the required beam properties, demonstrating beam correction, beam formatting and lens aberration correction
- Design and construction of fully packaged and operational HPDL laser modules
- Carrying out material processing trial using HPDL modules and analysing results

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