High power fibre lasers

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Abstract:
Recent progress in the development of high power fibre lasers will be reviewed, and the prospects for scaling output powers to well beyond the hundred watt level, whilst maintaining diffraction-limited beam quality will be discussed.

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Summary

Power scaling of solid-state lasers to meet the requirements of ever-demanding applications is and is likely to remain an important activity in the field of laser research. The chief obstacle in conventional 'bulk' solid-state lasers is heat generation within the laser medium and its deleterious effects, notably aberrated thermal lensing, which can degrade beam quality and efficiency. Over recent years there has been much interest in cladding-pumping of fibre lasers as an alternative technology for achieving high output power. Fibre-based sources benefit from a geometry which allows relatively simple thermal management, with the heat generated due to the laser pumping cycle distributed over a long length, reducing the likelihood of thermally-induced damage. Moreover, the output beam quality is generally determined by the waveguiding properties of the core, which can easily be tailored to produce a single-spatial-mode output beam. Recent demonstrations of cladding-pumped fibre lasers with near-diffraction-limited output beams at power levels in the ~100W regime [1],[2],[3] serve as a convincing demonstration of the future potential of fibre-based sources. However, scaling to much higher power levels is going to be quite challenging and is likely to need a radical change in fibre laser architecture. There are three main issues which must be addressed: Firstly, the effective core area must be increased to avoid unwanted nonlinear processes and intensity-induced damage, whilst maintaining freedom from thermal effects and whilst retaining the ability to select a single-spatial-mode. Secondly, a practical means for efficiently launching pump light from very high power diode sources (e.g. diode-stacks) into the fibre is needed, and, finally, a fibre geometry which allows efficient operation on a single-polarisation is also required. Over the last few years there has been increasing research activity directed towards finding solutions to the above problems with particular emphasis on designs which increase the effective core area whilst maintaining good beam quality.

In this presentation, I will review recent progress in the development of high power fibre lasers, discuss their advantages and disadvantages compared to conventional 'bulk' solid-state lasers, and describe some new power-scalable architectures for fibre lasers, which offer the prospect of single-mode output powers well beyond the hundred watt level.

References

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