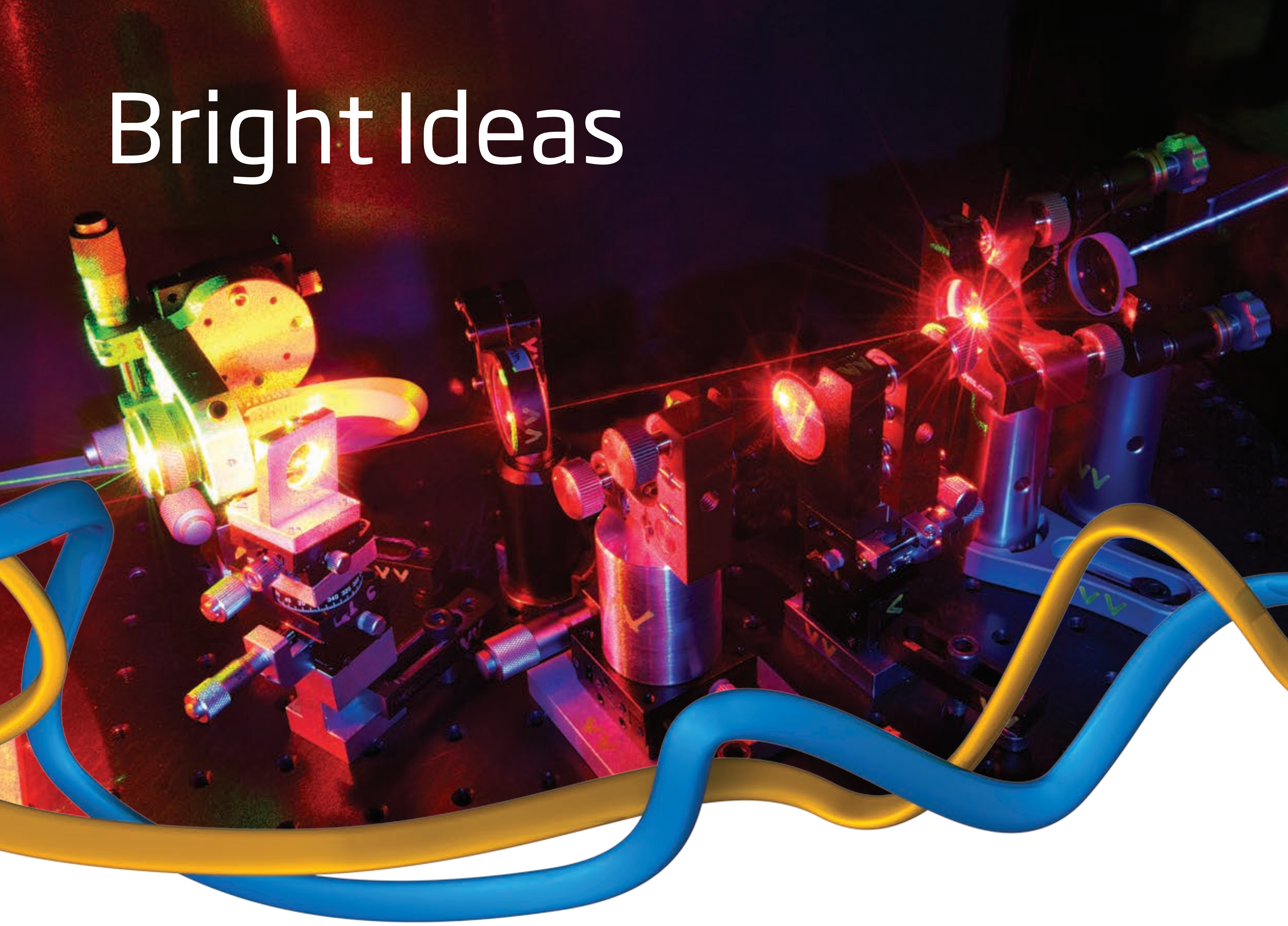
Bright Ideas



Dr Jennifer Hastie leads research into new kinds of semiconductor laser that have not been built before. These lasers are easily tuneable, even at visible and ultraviolet wavelengths, which make them highly applicable in many fields – especially Biophotonics.

ROYAL ACADEMY OF **ENGINEERING**

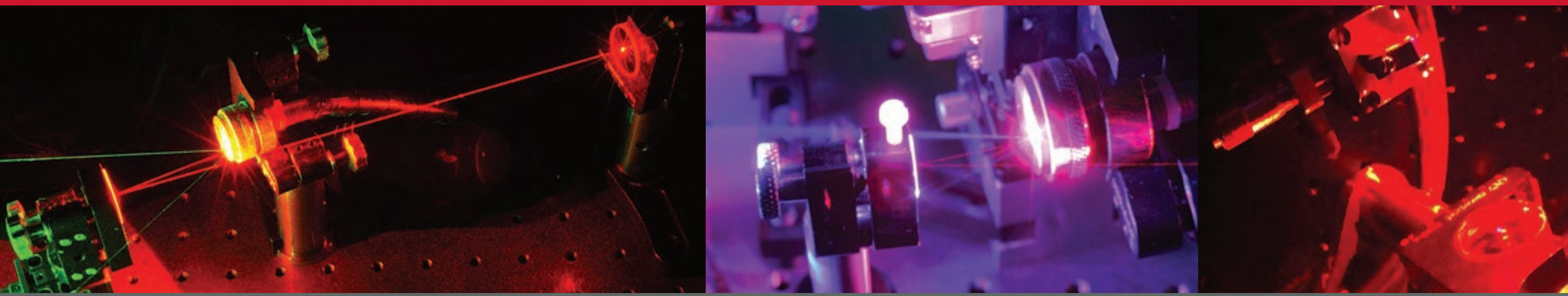
Research area

Dr Jennifer Hastie is a Research Team Leader at the Institute of Photonics, Strathclyde University. Her research work has focused on the development of optically pumped (using light as the 'fuel') semiconductor disk lasers (SDLs) that use novel semiconductor materials and nonlinear conversion techniques. This enables the lasers to operate at novel wavelengths. Conventional semiconductor lasers are electrically injected, and the advantage of optically pumped devices is that they offer high beam quality with relatively high output power, and this improves the brightness of the laser significantly. Dr Hastie's work on this type of laser began with her PhD thesis when she worked on solving an issue that held back the development of these lasers: managing the heat they generate when in operation. "We optimised the heat removal using transparent materials with exceptional thermal conductivity, such as silicon carbide and diamond, and could demonstrate higher power for these lasers at any SDL emission wavelength," she said.

With the practicality demonstrated, Dr Hastie's work during the period of her Royal Academy of Engineering Fellowship was directed towards expanding the spectral range of these devices. Dr Hastie said, "Previous SDLs operated in the invisible infrared range, but we saw an opportunity to target our work towards the applications-rich areas of visible and ultraviolet where it is much more difficult to get conventional compact laser sources.

"The principal advantage of these lasers is our ability to tailor the wavelength to meet different application needs – they are more easily engineered than others". The work involved designing the semiconductor structure that provides the amplification at the desired wavelength within the laser, sometimes using novel materials, then working with external fabrication specialists to produce the structure, followed by further refinement and performance testing.

Dr Hastie's research during her Academy Fellowship was further supported by project funding from EPSRC. This supported her work on ultraviolet SDLs for use in biophotonics and on indium phosphide quantum dot SDLs. The second of these projects was in collaboration with researchers at Cardiff and Sheffield Universities.



Academy support

Jennifer Hastie was supported by a Royal Academy of Engineering Research Fellowship. This gave her the opportunity to apply for further research funding immediately after her PhD. She said, "It enabled me to build up a research record and put me on the academic track earlier than is usual. It gave me a step up and any other research success that I've had has stemmed from that."

Other support

During her Academy Fellowship, Dr Hastie has been a principal and a co-investigator on different research projects funded by EPSRC totalling £1.1 million; other EPSRC projects have followed since. Her current Challenging Engineering grant of £1 million supports the research work of her team at the Institute of Photonics and she is actively pursuing other support from research organisations and industrial funders.

Research impact

The focus of Dr Hastie's research is the development of new types of laser, strongly motivated by potential practical applications. "We work closely with people in industry and other research fields who have good knowledge of the applications," she said, "so we know what the 'useful' performance of a laser is and can then guide our work towards it."

The SDLs produced through her work are more compact and more efficient than more conventional laser sources at similar wavelengths, and the added tuneability of her laser sources means that there will be a wide range of applications ready for them. Current fields that could benefit from these tuneable lasers include biophotonics – the study of biological cells and tissues using optical techniques – and spectroscopic analysis of gases. "Many of the early applications are in scientific and research laboratories," Dr Hastie said, "but the beam quality, flexibility and tuneability mean that wider application outside laboratory work is likely, and their compactness means the lasers can be accommodated more easily inside systems than other laser types."

Future challenges

Dr Hastie's current research builds upon her earlier work and aims to develop further both the optically pumped SDL technology and the range of applications it can be applied to. Systems for ultra-precision lithography, spectroscopy and metrology are among those being investigated. She has also worked on an EPSRC Engineering Platform grant on the development of advanced solid-state laser systems and a grant on diamond-based Raman lasers where her group was able to demonstrate the first tuneable diamond-based laser.

Dr Hastie is now gearing up for the next scientific challenges in her research. She said, "We're looking to take our experience in short wavelength SDLs and to get the full potential from the unique capabilities of this type of laser source. In particular, we are looking at very narrow spectral linewidths or long coherence lengths – what we refer to as high finesse performance – and further wavelength flexibility."

Biography/ Career progression

2000 - 2004 PhD, High power surface emitting semiconductor lasers, University of Strathclyde

2004 - 2009 Royal Academy of Engineering/EPSRC Research Fellowship, Institute of Photonics, University of Strathclyde

2006 - 2012 Senior Research Fellow and Associate Team Leader, Institute of Photonics, University of Strathclyde

2011 - Present EPSRC Challenging Engineering Award, Institute of Photonics, University of Strathclyde

2012 - Present Research Team Leader, Institute of Photonics, University of Strathclyde

Key achievements

Dr Hastie is a senior member of international optical and engineering societies and sits on the technical programme committees of leading conferences and meetings on lasers. In 2011, she was appointed a member of the Royal Society of Edinburgh's Young Academy of Scotland.

"A huge benefit of the Royal Academy of Engineering Research Fellowship was that it enabled me to start applying for research funding straight away after finishing my PhD. It put me on track."

Dr Jennifer Hastie