Research Fellowship

The Royal Academy of Engineering

Compact and ultra-versatile lasers based on quantum-dot materials

Co-funded by EPSRC

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Introduction

Instead of emitting a continuous beam, an ultrafast laser concentrates its energy into incredibly short bursts of light, resulting in very intense optical pulses. Because the pulses "happen" so quickly, their effects are concentrated in time and can be used to cut something out before the energy from the pulse heats up and possibly damages the surrounding area. The potential of these lasers has been realised in biomedical applications such as cutting biological tissues and cells with extreme precision, without collateral damage. Ultrafast lasers are also exploited in non-invasive imaging techniques which can probe into live cells and tissues, without disrupting their biological activity.

However, currently available ultrafast lasers present many disadvantages:

- High complexity and large footprint
- High cost of ownership (£100k - £500k)
- High cost of maintenance
- <u>No flexibility (spectral/temporal)</u>

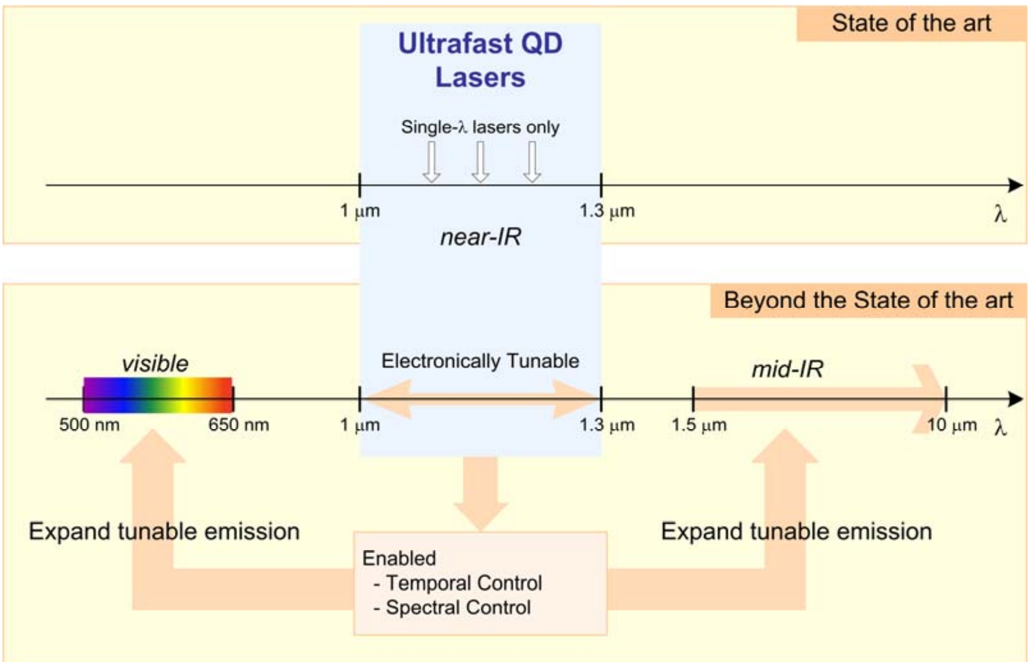
→The widespread use of ultrafast lasers and the discovery of new applications are strongly limited by these problems.

Goal of this Fellowship: a new generation of lasers

There is therefore a real need for developing the science and technology of **ultrafast laser sources** that are **low-cost, hand-held and turn-key** and that **can generate optical pulses which the end-user can easily adjust with an electronic control.**

To achieve this goal, I will use novel semiconductor nanomaterials called **quantum dots**. Our previous results demonstrated the potential of these materials for the generation of ultrashort pulses. I will now exploit their unique light-generating properties to develop **high-performance, pocket-sized lasers** where the **pulse duration and wavelength can be electronically controlled over a wide range**.

I am also collaborating with Life Scientists to apply these novel lasers in the development of optical tools for cell imaging and medical diagnosis.

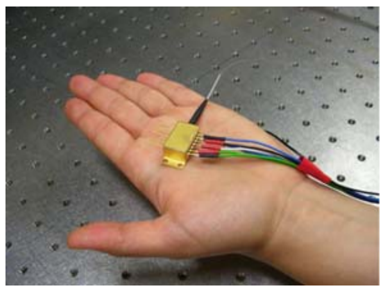


High-impact enabling technology

Priority application area: Biomedical Sciences

Scientific Impact

- Boosts the discovery of new biological phenomena or new regimes of laser-tissue interaction
- Enhances the development of novel and compact diagnostic/therapy tools



Societal Impact

- UK at the forefront of healthcare technology
- Minimally-invasive diagnostic/therapy tools
- Quality of life of patients

Industrial and Economic Impact

- Enabling widespread use of ultrafast lasers → widening powerful applications + markets.
- Biophotonics is a fast-growing market → excellent business opportunity.

WIDER Impact

- Other existing ultrafast applications will benefit
- Open up completely new applications

EPSRC Engineering and Physical Sciences Research Council

University of Dundee