Compact Ultrafast Laser Sources Based on Novel Quantum Dot Structures (FAST-DOT)

Research Areas
- Tool Development
- Product Development

At a Glance
- Status: Completed Consortium
- Year Launched: 2008
- Initiating Organization: European Commission Seventh Framework Programme (FP7)
- Initiator Type: Government
- Location: Europe

Abstract

Compact Ultrafast Laser Sources Based on Novel Quantum Dot Structures (FAST-DOT) was a €14.75 million project coordinated by the University of Dundee, with a project consortium consisting of 18 of Europe’s leading photonics research groups and companies from 12 different countries. The project’s aim was to take advantage of the unique properties of nano-materials based on quantum dots (QDs) to develop a new class of miniature lasers designed specifically for biomedical and imaging applications such as multi-photon imaging and cell surgery. FAST-DOT delivered significant advances and world-record performances in defining the unique properties of semiconductor nano-materials based on QDs to realize a new class of semiconductor laser components.

Mission

FAST-DOT was an experimental program funded under the Seventh Framework Programme of the European Union (Photonic components and subsystems). Beginning in June 2008 and running for two years, FAST-DOT’s purpose was as follows:
Structure & Governance

The work plan structure was constructed to build momentum in the project from solid foundations in application-informed, novel, QD material growth (Work Package (WP) 1) through to acquisition of insight and understanding at the device development and characterization level (WPs 2-5), culminating in integration, application, and prototype development in biomedical photonics (WPs 6-7). Impact and dissemination were coordinated through the activities of WP8, and the whole undertaking was managed through the project management, scientific direction, and biophotonic application oversight of WP9.

FAST-DOT's foundation was the development of high-quality materials and nonlinear crystals in WP1 for exploitation in WPs 2-5. Thereafter the strategy was to exploit these in four different directions:

- **WP2**: The consortium can already demonstrate strong preliminary results in the demonstration of mode-locked QD lasers to produce broadband tunable and ultrafast pulse performance. FAST-DOT will fully exploit the preliminary results in creating a new generation of edge-emitting, mode-locked QD lasers.
- **WP3**: The achievement of the WP objective will constitute a completely new outcome for European photonics. The resulting laser sources will have broadband tunability, short-pulse duration, and efficient operation in the visible light spectrum suitable for biophotonic applications.
- **WP4**: The exploitation of new QD materials in optically pumped VECSELS will produce a step change in the performance of this technology, producing more powerful, but still broadband tunable, laser sources.
- **WP5**: The exploitation of new QD-SESAMs in mode-locked, solid-state, and fiber lasers based on commercially available crystals and fibers will create laser sources that deliver higher frequencies than is currently available in this technology.

The final element of the strategy was to demonstrate how the characteristics of these new devices can be exploited in biophotonic applications for minimally invasive medical diagnostics.

The work plan strategy and how it was implemented reflect the recommendations of the Photonics 21 Strategic Research Agenda in Photonics, which states: “All research in life sciences and health care have to be carried out in a strictly application oriented way, involving cooperation between the future...
applicants, and the research community in physics, chemistry as well as engineering.

The driving principles for the selection of WP leaders was that they had the command of the expertise to achieve the required outputs and that the project had the essential series of strong feedback loops to ensure that (a) characterization information was fed back into material growth strategies and design of laser sources based upon monolithic and external cavity configurations and (b) information from integration and biophotonic application work was similarly used to refine earlier conclusions.

The selection of the participants in the development of the underlying technologies and core photonic components (WPs 1-5) was conceived to optimize the feedback process, and they employed concurrent team-working methods, to prevent the downstream migration of error affecting the applications team in WP6.

The concurrent working strategy also supported the capture of the information necessary to create transferable design methodologies and optimal manufacturing technologies. The achievement of compact ultrafast and broadband laser sources optimized for biophotonic application was accompanied by the captured knowledge to change design parameters at each stage to optimize manufacturing efficiencies and costs.

Financing

FAST-DOT was financed under the Seventh Framework Programme.

Data Sharing

Dissemination kits with FAST-DOT data are available on the project website.

Impact/Accomplishment

During the project duration, excellent progress was made: Novel QD structures and devices were designed, fabricated, and evaluated by the project partners; detailed theoretical models were developed for the simulation of QD mode-locked lasers; and novel operating regimes for the mode-
locked lasers were identified. The obtained results were enormously encouraging and confirmed the great potential of this technology to enable future development of compact low-cost laser products capable of high-power, ultrashort pulse generation for applications in cell-surgery and multi-photon imaging.

The FAST-DOT project contributed significantly to advances in QD technology with 78 papers published in high-quality scientific journals and 157 papers presented at international conferences.

Links/Social Media Feed

Homepage  http://fast-dot.eu/

Points of Contact

University of Athens
Optical Communications Laboratory

Address:
Ilissia
Athens
Greece
15784

phone: +30 210 727 5322
fax: +30 210 727 5333

Sponsors & Partners

Alcatel Thales III-V Lab
ETH Zurich
ICFO-The Institute of Photonic Sciences
Innolume
KTH Royal Institute of Technology
M Squared Lasers LTD
MMI
Philips
Politecnico di Torino
Tampere University of Technology
Technische Universität Darmstadt
The Foundation for Research and Technology
Time-Bandwidth Products AG
TOPTICA
University of Sheffield
UOA Optical Communications Laboratory
Vilnius University

Updated: 04/14/2016