

Project:**Quantum Cascade Photonic Crystal Surface-Emitting Lasers and Normal- Incidence Detectors**

The objective of this research project is the development of vertically emitting unipolar micro-devices, in particular vertically emitting Quantum Cascade (QC) lasers, and corresponding normal-incidence detectors. QC lasers are a new family of devices whose potential has seen an explosion in the last few years. However, due to the natural transverse magnetic polarization of intersubband transitions, these lasers cannot be natural vertical emitters. This characteristic is nevertheless desirable for their miniaturization and integration, such as in multi-wavelength two-dimensional laser arrays for spectroscopy and gas sensing. The goal of this project is to develop vertically emitting QC microcavity lasers, and apply the same innovative technology to quantum well infrared photodetectors.

InGaAs/AlInAs and GaAs/AlGaAs QC structures will be used as active material. They will be manufactured into natural microcavity vertical emitters by exploiting the photonic crystal technology.

Photonic crystal interband lasers have in fact attracted attention due to the flexibility they afford the designer, like the ability to create emitters that can radiate either in-plane or vertically and can be incorporated into lithographically tuned multi-wavelength laser arrays.

We will develop both band-edge and defect mode QC intersubband lasers. The latter ones incorporate in the lattice an intentionally introduced defect, which is able to support spatially localized optical modes. A full control of the lasing mode will be achieved through careful design (via FDTD techniques) of the photonic crystal characteristics, and it will allow a precise engineering of the far-field emission pattern of the lasers.

As far as applications are concerned, this project will focus on improving the performances of the lasers in terms of current threshold, output power and maximum operating temperature. We will explore the possibility of miniaturizing photonic crystal QC lasers, and of integrating them into multi-? arrays. Finally, the use of the devices as detectors, and not only as emitters, will be investigated.

More fundamental topics will be studied too. Alternative approaches to realize effective photonic-band gap structures for TM radiation will be investigated. In particular structures based on photonic lattices with a basis, and rod-like PC structures will be fabricated. The use of surface-plasmons to efficiently extract the TM radiation from the photonic-crystal QC laser will be studied and optimized. Finally, the photonic-crystal QC laser technology will be applied to the THz range, where QC lasers only recently showed their potential.

Comments:

Outstanding researcher with a very innovative and ambitious project which will provide a real breakthrough in nano-photonics.

The candidate has very good academic and industrial experience, with an excellent publication record. Excellent scientist, enthusiastic and independent researcher with some clear successes to date. He has a clear vision of how to apply this physics in a very imaginative and creative way.

The project intends to combine quantum cascade lasers with photonic band-engineering in order to achieve new functionalities. The challenges and innovation issues are clearly explained. The impact on European scientific competitiveness in this area will be high and the proposal should form the basis of creating an excellent group in this field.

Excellent environment with the opportunity to cooperate with high level groups in related areas.

Nationality: Italian

Address: Institut d'Electronique Fondamentale, Bat. 220 Université Paris-Sud, 91405 ORSAY, France

Current institution: Institut d'Electronique Fondamentale (IEF)

New institution: CNRS UMR 8622, Institut d'Electronique Fondamentale (IEF),

Media Enquiries:

Jens Degett, ESF Communications Director

European Science Foundation, Strasbourg, France

Tel: +33 (0)3 88 76 71 32 – Fax: +33 (0)3 88 37 05 32 Email: jdegett@esf.org

