Research Topic for the ParisTech/CSC PhD Program

Field : Physics, Optics

Subfield: Applied Physics

Title: Smart Infrared Incandescent Sources

ParisTech School: Institut d'Optique Graduate School

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Short description of possible research topics for a PhD:
Incandescent sources are made of materials at temperatures above 1000 K. Thermal radiation is usually assumed to be spatially incoherent (quasi isotropic) and temporally incoherent (broad emission spectrum). Furthermore, these sources cannot be modulated in intensity above 10-100 Hz due to thermal inertia.

However, no fundamental physics law forbids an incandescent source to be directional, monochromatic, polarized and be modulated at frequencies as large as 50 MHz. By revisiting the physics of thermal radiation at the nanoscale, our team has demonstrated spatially coherent sources [1], and introduced the concept of thermal source with high modulation rate [2]. In this project, we aim at designing and fabricating mid infrared sources operating in the 3-13 μm range which are directional, can emit polarized radiation and can be modulated at frequencies higher than 50 MHz. We will use absorbing materials coupled to nanoantennas [3]. The design is based on the emission theory reported in ref. [4].

Required background of the student:
We are seeking a highly motivated student with a master in Physics. The physics involved in the topic includes optics, nanophotonics, statistical physics.
The student will do numerical modelling of the electromagnetic fields in a nanostructure, nanofabrication in a clean room of the emitters and the nanoantennas, measurement of the emitted radiation using infrared Fourier transform spectrometers (FTIR).

List of 5(max.) representative publications of the group:

1. Coherent emission of light by thermal sources, J.J. Greffet, R. Carminati, K. Joulain, J.P. Mulet, S. Mainguy and Y Chen, Nature **416** p 61 (2002)
2. Controlled incandescence, Jean-Jacques Greffet, Nature **478**, p 191 (2011)
3. Enhancing thermal radiation with nanoantennas to create infrared sources with high modulation rates, E. Sakat, L. Wojszvzyk, J.P. Hugonin, M. Besbes, C. Sauvan, J.J. Greffet, Optica **5**, 175 (2018).
4. Light emission by nonequilibrium bodies: local Kirchhoff law, J.J. Greffet, P. Bouchon, G. Brucoli, F. Marquier, Phys.Rev.X **8**, 021008 (2018).