POST-DOC POSITION

Subject: Exciton engineering in hybrid halide perovskites for lasers.

Workplace : Laboratoire Aimé Cotton, Campus d'Orsay, 91 405 Orsay, France

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Scientific context:

Since 2012, hybrid organic-inorganic halide perovskites (HOP) have raised a lot of attention due to their applications in photovoltaics, reaching a power conversion efficiency as high as 23.7%. [1] However, one of the main technological issues is the stability of the material, especially its sensitivity to moisture. In this context, 2D layered HOPs of chemical formula $(RNH_3)_2(CH_3NH_3)_{n-1}Pb_nX_{3n+1}$ (R: organic group, X: halogen) have recently demonstrated superior stability [2]. The material adopts a two-dimensional structure: the n variable corresponds to the number of inorganic layers intercalated between the organic molecules. Carriers are confined in the atomically thin inorganic layers, made of n layers of PbX_6 octahedras Due to quantum and dielectric confinements, strongly bound excitons are formed. [3]. These strong excitons present a lot of interest especially for light emitting devices such as electroluminescent diodes and lasers. Additionally, these materials will allow to address the problem of the "green gap" of the laser sources as an emission in the green range can be easily obtained by choosing the nature of the halogen X and/or the value of n.

However, performances of the HOP-based lasers are limited by the low crystallinity of HOP thin films, which induces important non-radiative losses. In order to overcome this problem, the LAC team has recently developed a synthesis method leading to monocrystalline thin films of 2D-layered HOP: the "Anti-Solvent Vapor-assisted Capping Crystallization" (AVCC method) [4]. These films present a low density of defects, making them promising candidates for HOP lasers.

References :

[1] NREL Chart http://www.nrel.gov/ncpv/images/efficiency_chart.jpg.
[2] H. Tsai, *et al.*, Nature **536**, 312 (2016).
[3] K. Gauthron, *et al.*, Opt. Express **18**, 5912 (2010).
[4] F. Lédée et al, Cryst. Eng. Comm. **19**, 2598-2602 (2017).

Activities: AVCC monocrystalline thin layers containing different organic cations, halogens and n values, will be synthesized in collaboration with the chemical engineer of the group, with the objective to optimize the emission properties. The excitonic dynamics, Amplified Spontaneous Emission and photostability will be investigated using time-resolved micro-photoluminescence as a function of temperature and incident fluence. Microcavities containing HOP thin monocrystalline layers with the optimized omposition will be realized and the laser emission will be studied.

Skills: Candidate with a strong interest for experimentation is expected. A strong background in optical spectroscopy of inorganic or organic semiconductors is expected. Skills in material science are not compulsory but are a plus.