POST-DOCTORAL POSITION

1 year, European project GOTSOLAR : http://gotsolar.eu

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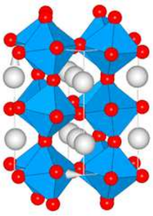

Fig 1 : Structure of $CH_3NH_3PbX_3$

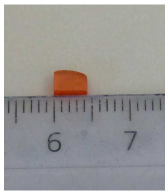

Fig 2 : $CH_3NH_3PbI_3$ and $CH_3NH_3PbBr_3$ monocrystals

Since 2012, the hybrid organic-inorganic perovskites $CH_3NH_3PbX_3$, where X is an halogen: I, Br, Cl (fig. 1) represents a “material breakthrough” for photovoltaïcs: in only 3 years, the efficiency of $CH_3NH_3PbI_3$ based solar cells has progressed from 12% to 22% [1]. Several decisive properties of this semiconductor explain this spectacular breakthrough: good ambipolar transport properties, mobilities as high as several 10 $cm^2.V^{-1}.s^{-1}$, large diffusion lengths of the carriers of several 100 nm, a bandgap tuning easily performed by substitution of X or using mixed halide ion compositions. Since 2014, it appears also that the properties of the hybrid perovskites are very interesting, not only for photovoltaic cells but also for light emitting devices. Nevertheless, the detailed photophysics of these semiconductors are still unknown and are quite necessary to optimize the properties of the material for both photovoltaïcs or emitting devices applications.

Until now, the fundamental studies are usually performed on spin-coated hybrid perovskite thin layers [2,3]. These thin layers are highly polycristalline and the quality of the layers depend strongly on the synthesis conditions and on the substrates. As a consequence, the studies show a great variability of the electronic properties as a function of the morphology of the polycristalline thin layers, since the optical properties are dominated by the defects at low temperature. In particular, the size of the crystallites, varying between several 100 nanometers to several micrometers, has a great impact on the gap energy, the lifetimes and the excitonic properties [4,5].

LAC team has recently synthesized millimeter scale hybrid perovskites crystals through chemistry in solution (fig. 2). These bulk crystals have been demonstrated to be monocrystals, having a very low density of defects, thus allowing to study the intrinsic properties of the material. Carrier diffusion lengths, carrier dynamics, carrier-carrier interactions, relation between morphology and luminescence will be investigated. These studies will be performed by means of photoluminescence, micro-photoluminescence, time-resolved photoluminescence and femtosecond pump-probe spectroscopy as function of temperature.

LAC group has a huge expertise of hybrid perovskites: optimization and optical properties of the material [6], introduction of the material in vertical microcavities working in the strong coupling regime in the framework of polaritons lasers [7,8].

[1] NREL (National Renewable Energy Laboratory) chart :
http://www.nrel.gov/ncpv/images/efficiency_chart.jpg
[2] Y. Yamada et al, *JACS* **2015**, *137 (33), 10456–10459.*
[3] C. Wehrenfennig et al, *. APL Mater.* **2014**, *2, 81513.*
[4] H.-H. Fang et al, *Adv. Funct. Mater.* **2015**, *25 (16), 2378-2385.*
[5] V. D’Innocenzo et al, *JACS* **2014**, *136 (51), 17730–17733.*
[6] G. Lanty et al, *J. Phys Chem. Lett*, **2014**, *5*, p 3958-3963
[7] G. Lanty et al, *Appl. Phys. Lett.* **2008,** *93*, p 81101
[8] H. S. Nguyen et al, *Appl. Phys. Lett.* **2014**, *104*, p 081103- 081107.