



Ircelyon

INSTITUT DE RECHERCHES  
SUR LA CATALYSE  
ET L'ENVIRONNEMENT

## PhD proposition

**Name of the laboratoires :** Institut de recherche sur la catalyse et l'environnement (IRCELYON), UCBL, CNRS and Institut des Nanotechnologies de *Lyon* (INL), ECL, UCBL et CNRS

**Persons-in-charge:** Dr. Shashank MISHRA (team C'durable, IRCELYON)  
Dr. Christian SEASSAL (team i-Lum, INL)

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**PhD title:** Chemical routes to upconverting materials integrated in metasurfaces for photocatalysis and Photodetection

This PhD work will be carried out in the framework of the ANR project **README**, which is an interdisciplinary and collaborative project among INL, IRCELYON and ILM. The project aims to combine lanthanide-doped upconverting materials and optical metasurfaces to control and optimize the upconversion efficiency, and achieve highly non-linear regimes such as photon avalanche for photocatalysis and Photodetection. This PhD work involves synthesis and integration of upconverting nanomaterials in metasurfaces using solution- and vapor-phase chemical methods, and nano-imprint lithography (NIL). It will have following different tasks:

(i) **Design and synthesis of novel volatile molecular precursors of lanthanides for the vapor phase deposition of metal fluoride-based upconverting thin films.** This is an important and a key task of the PhD, which involves synthesis and complete characterization of new fluorinated metal complexes, studies of their thermal and vapor pressure properties and chemical vapor deposition of the precursors showing optimal volatility and mass-transport properties to achieve good quality  $\text{Yb}^{3+}$  and  $\text{Tm}^{3+}$  co-doped  $\text{LnF}_3$  and  $\text{MLnF}_4$  ( $\text{M} = \text{Li, Na}$ ;  $\text{Ln} = \text{Y, Gd}$ ) UC thin films.

(ii) **Dip-coating deposition of UC nanoparticles synthesized by Metal-Organic Decomposition (MOD).** In parallel, UC NPs will be deposited and integrated within the metasurfaces in the form of embedded-in-mesoporous silica or titania films by solution-phase routes (e.g., spin-coating). Such films will be patterned by NIL. The MOD synthesis of UC NPs with high quantum yield has previously been established in the lab, so current task will mainly focus on the optimization of the best conditions for the deposition and the process parameters for the NIL.

(iii) Finally, the upconverting metasurfaces will be integrated with  $\text{TiO}_2$ -based photocatalysts, which will then be characterized and tested for the photocatalytic properties.

The PhD student will be integrated within the C'durable team of IRCELYON and the i-Lum team of INL. He/she will work in tandem with partners and collaborators of the README project for completing different tasks such as thin film deposition by MOCVD and ALD, NIL of sol-gel films, upconversion and photocatalytic measurements, etc. Frequent meeting among the project partners will be organized to monitor the progress of the project.

**Candidate's profile:** For this multidisciplinary PhD position, we seek a candidate who has a master's degree in Chemistry or Physics with a good grade and some hand-on experiences in one or more fields of molecular engineering, nanoparticle and thin films. Interested candidates should send their CV and motivation letter to persons-in-charge C. Seassal and S. Mishra.

