

Director : Marc Foumigué

Deputy Director : Maryline Guilloux-Viry

143 academic researchers, 71 CNRS, 88 engineers and technical agents = 302

25 temporary contracts, 211 PhDs, 43 Post-docs

Thematics cover all the aspects of chemistry: from the synthesis to the integration into devices

- Materials for sustainable development: eco-materials and eco-processes
- Materials for the conversion of energy
- Molecules and materials for health

8 research teams

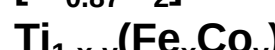
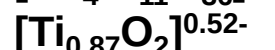
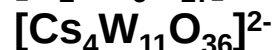
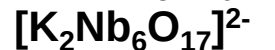
CIP : Chimie et ingénierie des procédés	Cmet : Chimie et métallurgie	COrint : Chimie Organique et interfaces	CSM : Chimie du Solide et Matériaux	CTI : Chimie théorique Inorganique	MaCSE : Matière Condensée et Systèmes Electroactifs	OMC : Organo- métalliques : Matériaux et Catalyse	V&C : Verres & Céramiques
CNU 33/62	33/58	32/86/85	32/33/85	31	32	14/32	33/57/58
CNRS		32/86/85	15/14	14/15	13	14/11	15
44 people in GDR NAME	1	0	1	19	6	4	3
							10

Preferred axis for GDR : elaboration & simulation

CSM – Oxides thin films and nanosheets

Elaboration ; thin films ; piezoelectric ; characterizations (chemical, structural, morphological)

2D oxides:

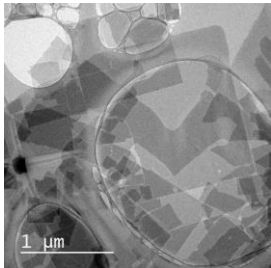


1-20 μm wide, 1.5-3 nm thick

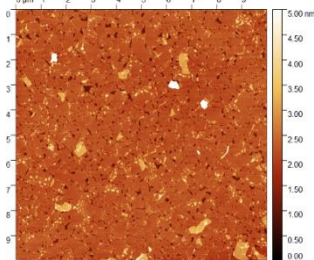
High-k dielectrics

Ferromagnetism @RT

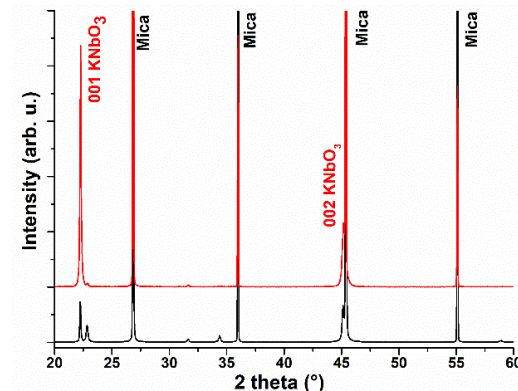
TEM of 2D oxides



2D oxide on mica



i) Preferential growth of piezoelectric film on flexible mica



Type de conversion d'énergie

Piézoélectrique

Application relative à l'énergie ou autre

Récupération

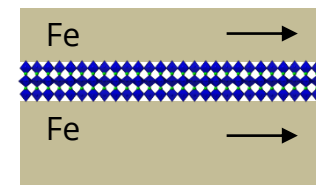
Stockage

Capteurs

Dispositifs flexibles

Magnetic tunnel junction

ii) Potentiality for spintronic



Lead-free piezoelectrics / ferroelectrics in thin films
(PLD, CSD) (K,Na)NbO₃ / KNN ; K(Ta,Nb)O₃ / KTN



CSM - Nano-size clusters-based composites for energy conversion

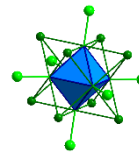
From the solid state synthesis of luminescent clusters to their:

- integration in organic matrices or inorganic matrices
- Immobilization onto surfaces (graphene, silicon, gold)

Top down approach

Hybrid liquid crystals and copolymers, nanoparticles

Solar cell concentrator, sensors, lighting and displays, solar control windows



CSM - Nano-size clusters-based: photoelectrodes for solar energy conversion

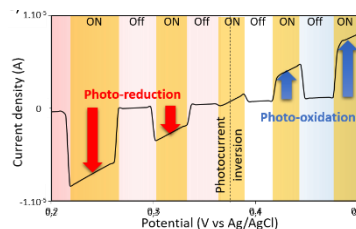
Photoelectrochemical and photovoltaic cells

Deposition techniques: CSD (doctor blading, spin coating, etc.) or electrochemical deposition

Photoelectrochemistry (photoactivity and stability) and electrochemical impedance spectroscopy (EIS)

Search for collaboration : transient absorption H_2 determination ???

Bipolar properties of Mo_6 -based photoelectrodes.



AXE
Élaboration
Porteurs d'énergie
Photon
Type de conversion d'énergie
Conversion de longueurs d'ondes
Caractéristiques physicochimiques
Optique
Application relative à l'énergie ou autre
Récupération, capteurs
AXE
Élaboration
Porteurs d'énergie
Photon → électron
Type de conversion d'énergie
Photovoltaïque
Caractéristiques physicochimiques
Caractérisation microstructurale
Electrique
électrochimique
Application relative à l'énergie ou autre
Récupération: production H_2 , génération courant

CSM: Synthesis of Transition Metal (Oxy)Nitrides and Sulfides by Solid-Gaz Reaction

- (Oxy)Nitrides and Sulfides / 5 to 100 nm
- Powders and Thin Films
- Bottom-up
- Soft and Solid State Chemistry
- Structural Characterization
- Catalysis, Thermoelectricity

AXE

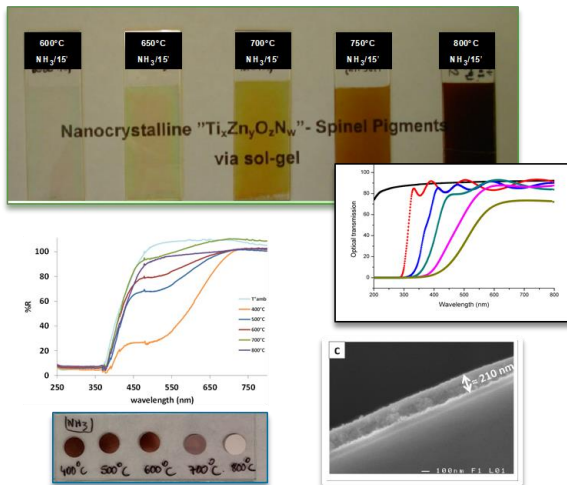
Élaboration

Type de conversion d'énergie

Thermoélectrique

Application relative à l'énergie ou autre

Récupération



Verres et Céramiques

AXE

Élaboration

Porteurs d'énergie

Phonon

Type de conversion d'énergie

Photocatalyse

- ✓ Tantalum-based nitride nanopowders
- ✓ Nitrogen containing perovskite derived nanosheets from exfoliation of layered oxynitrides materials
- ✓ Chalcogenide-based nanocomposite containing p/n junctions

Type de conversion d'énergie

Photovoltaïque

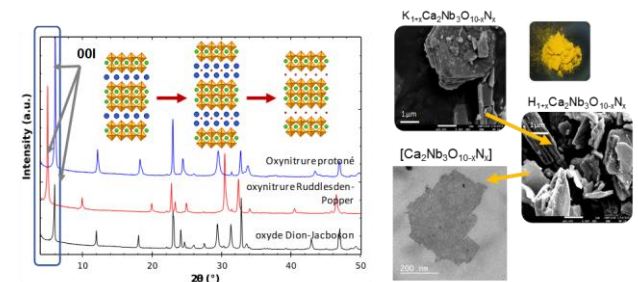
- ✓ Non-stoichiometric oxide nanoparticles (NiO, ZnO)
- ✓ Chalcogenide-based nanocomposite containing p/n junctions
- ✓ Controlled nanocrystallisation of doped Sb_2Se_3 thin films

Type de conversion d'énergie

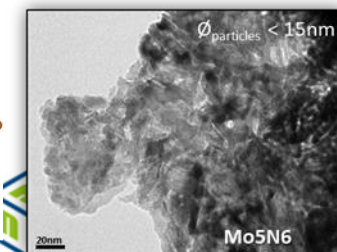
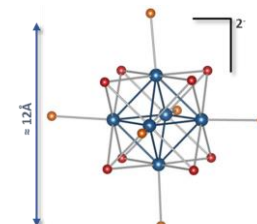
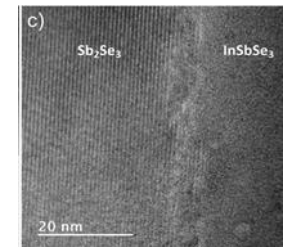
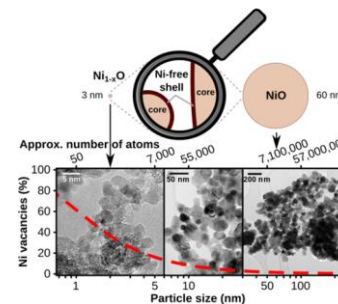
Catalyse hétérogène (HER, WGS)

- ✓ Original access to nanostructured transition metal nitrides (Mo_2N , Mo_5N_6) and carbides (Mo_2C) from metal clusters $((\text{TBA})_2\text{Mo}_6(\text{Br/Cl})_{14})$

- Formulation-Synthèse-Structure
- Photoniques et capteurs infrarouges
- Conversion et stockage d'énergie



Pérovskites oxynitrides lamellaires – Réactions d'intercalations/échanges cationiques



Verres et Céramiques

Type de conversion d'énergie

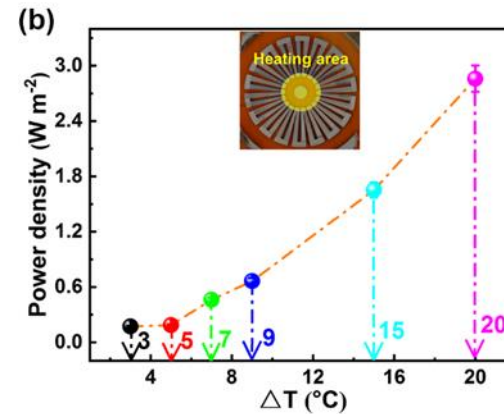
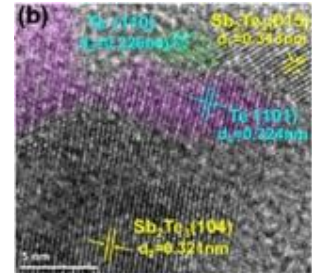
Thermoélectrique

- ✓ Chalcogenide-based thin film with nanodomains for flexible thermoelectric components

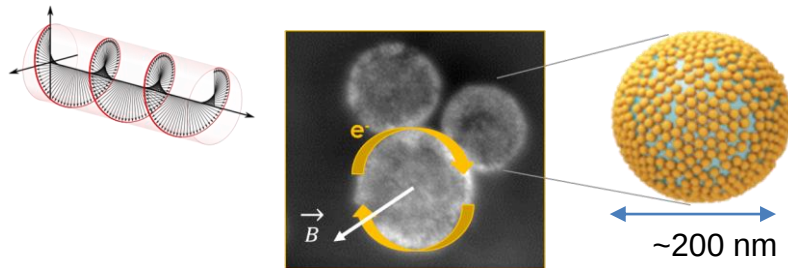
Porteurs d'énergie

électron

- ✓ Nanopowders for optimizing solid batteries interfaces



CORint: Plasmonic Nanoparticles self-assembly into nanoresonators



Action of a plasmonic nanoresonator upon the magnetic component of light

Applications targeted: Metamaterials: optical magnetism, light concentration...

Porteurs d'énergie

Photon

Application relative à l'énergie ou autre

Capteurs

Gestion thermique des nanodispositifs

Concentration lumière

CIP: Electrokinetic characterizations of materials

- **Materials:** dielectrics, semi-conductors, metals...
- **Dimensions:** particles and fibers (nm $\rightarrow$ mm), thin films and porous materials (a few cm²)
- **Methods:** Streaming Current, Streaming Potential and Laser Doppler Electrophoresis
- **Applications:** Surface functionalization, adsorption, surface treatment, material ageing...

MaCSE - Conversion of Electric Energy to Chemical Energy (catalytic electrodes) and Light Energy to Chemical Energy (catalytic photoelectrodes)

- Expertise:** (Photo)Electrochemistry; Surface Functionalization; Electrocatalysis; Nanomaterials
- Elaboration:** Dip- and spin-coating; Electrodeposition; Surface grafting
- Methods:** Electrochemistry (cyclic voltammetry, electrochemical impedance spectroscopy); Photocurrent spectroscopy; UV photolithography; Gas chromatography

AXE

Élaboration

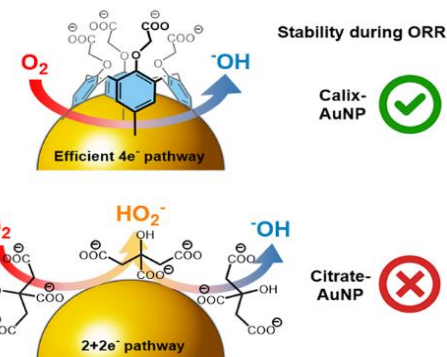
Caractéristiques physicochimiques

Electrique

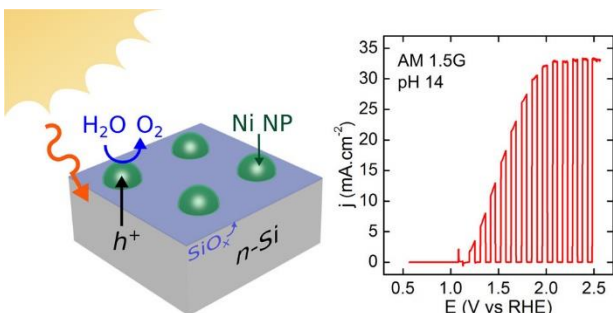
Current research topics:

- 1) Electrocatalysis of O_2 and CO_2 reduction: development of a molecules@materials concept for boosting the selectivity and/or durability of nanocatalysts

Q. Lenne, A. Mattiuzzi, I. Jabin, N. Le Poul, Y.R. Leroux, C. Lagrost, *Adv. Mater. Interfaces*, **2020**, 2001557

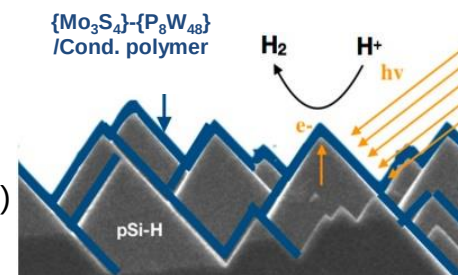


- 2) Ni nanoparticles-modified photoanodes for sunlight-driven O_2 evolution reaction



- 3) Polyoxometalate-modified microstructured photocathodes for sunlight-driven H_2 evolution reaction

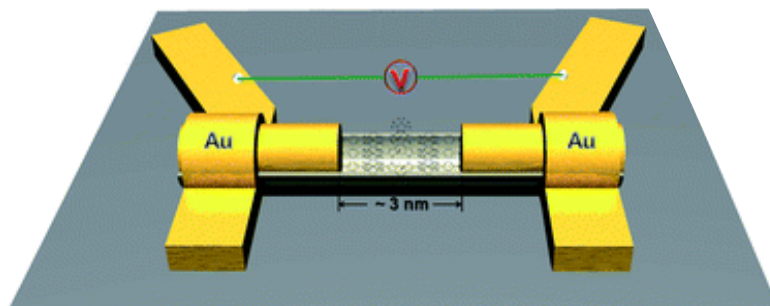
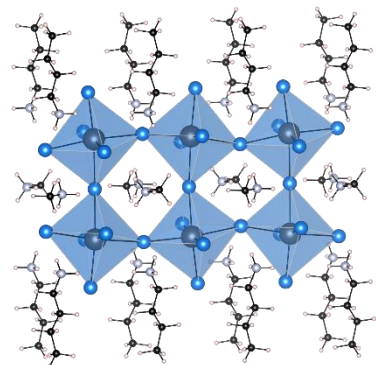
(B. Fabre, and co. *J. Am. Chem. Soc.* **2019**, 141, 11954)
ANR Chalco-Cat 2015-2019



G. Loget, et al. *ACS Energy Lett.* **2017**, 2, 569; *Nature Commun.* **2019**, 10:3522

CTI - Computational Chemistry

Halide perovskites (3D, 2D and 0D) &
Molecular junctions (Organometallics, OMC)



- DFT, DFTB, TD-DFT, NEGF, BSE
- QuantumEspresso, SIESTA, VASP, ADF, Gaussian, etc.

AXE

Simulations/Théorie

Porteurs d'énergie

Photon

Phonon

Type de conversion d'énergie

Thermoélectrique

Photovoltaïque

Application relative à l'énergie ou autre

Récupération

Cellules solaires

nanodispositifs

