



IMMM

Institut des Molécules
et Matériaux du Mans



Réseau Français du Fluor - CNRS



Team: crystallized and vitreous Fluorides

- 2 research themes :
- Crystallized fluorides
 - Fluoride glass planar waveguides

cross-disciplinary theme : Modelisation of fluorides by solid state NMR

(collaboration with the team of the dpt PEC of IMMM*)

- Keywords :**
- synthesis, hydrothermal, solvothermal, microwave, crystal, structure, nanoparticles, inorganic fluoride, hybrid fluoride, adsorption, electrochemistry
 - fluoride glass, glass-ceramic, PVD, planar waveguides, rare earth luminescence, up- and down-conversion, frequency conversion

Staff members: Body Monique*, Boulard Brigitte, Galven Cyrille, Gao Youping, Leblanc Marc, Legein Christophe*, Lhoste Jérôme, Maisonneuve Vincent, Ribaud Annie



Crystallized fluorides

Elaboration of fluorides for applications in the domain of energy

Methods

Hydro-Solvothermal synthesis of inorganic and hybrid fluorides in sub- or supercritical conditions by conventional or microwave heating of nano- microparticles

Structural characterization (powder, single-crystal), thermal analysis, TEM, SEM,...

Gas adsorption, electrochemical properties, optimization by the methodology of experimental design

Subjects

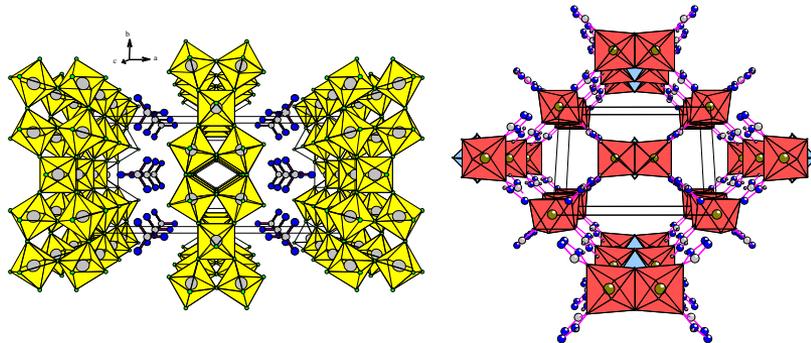
- *Exploration of new chemical systems including metallic cations (Ti^{4+} , Al^{3+} , Fe^{3+} , Fe^{2+} , Zn^{2+} , ...) and aromatic amines to elaborate hybrid fluorides with modulated porosity for gas storage or battery cathodes*

- *Synthesis and structural investigations of nano- and micro-structured inorganic fluorides*

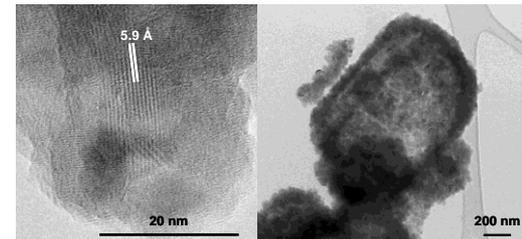
- *ANR FLUOBAT (2012-2016): Find the best constituting fluoride materials combinations (electrodes and electrolyte) to demonstrate the possible industrial developments of solid state fluorides ion batteries*
(www.fluobat.fr)

Collaborations (academic, industrial)

Electrochemical properties (H. Groult, ANR FLUOBAT, PHENIX, A. Demourgues and A. Tressaud (ANR FLUOBAT, ICMCB), gas adsorption (J. -L. Bobet, ICMCB), P. Lightfoot (Université St Andrews, Ecosse), A. Ben Ali (Bizerte, Tunisie), Comurhex, AREVA, Péchiney,...



Hybrid fluorides: 2D of class I (left) and 3D of class II (right)



LR-TEM (left) and HR-TEM (right) images of nanostructured β - AlF_3

Fluoride glass planar waveguides

Elaboration of rare-earth doped fluoride glass waveguides for active planar optic

Methods

- PVD deposition method (coevaporation), evaporation of fluoride glass and of rare-earth fluoride mixtures for codoping (Er^{3+} , Pr^{3+} , Tm^{3+} , $\text{Pr}^{3+}/\text{Yb}^{3+}$, $\text{Er}^{3+}/\text{Yb}^{3+}/\text{Ce}^{3+}$, $\text{Er}^{3+}/\text{Tm}^{3+}/\text{Yb}^{3+}$)
- Thermal analysis of glasses, optical and spectroscopic characterization of bulk and waveguides
- Glass to crystal transformation (transparent glass ceramic) by heat treatment - study of structure and morphology by XRD, TEM, NMR

Subjects

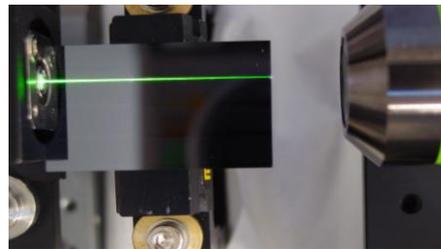
- Active planar optic: optical amplification, miniaturized laser sources, frequency conversion
- Codoping of glasses and glass ceramics for up- and down-conversion (low and high doping up to 20 mol%)
- Exploration of fluoride vitreous systems able to be evaporated

Collaborations (academic)

spectroscopic properties (M. Ferrari, IFN Trento, A. Monteil, LφA Angers and LPCML Lyon), fabrication and optical characterization of waveguides (V. Nazabal, Sciences Chimiques Rennes)



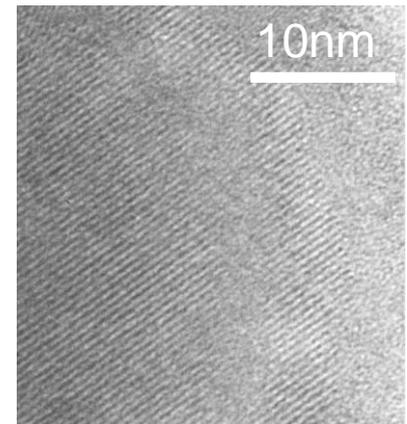
PVD evaporator in clean room



Er^{3+} -doped fluoride glass channel waveguide



glass to crystal transformation



TEM image of a glass-ceramic