2015-2016

Internship proposal (Master 2 or final internship) at the LMGP

Crystal growth and physical properties of nano-lamellar carbides

Context

MAX phases are unique nano-lamellar compounds (Fig.1) because they combine the good properties of metals to that of ceramics. Their formula is $M_{n+1}AX_n$ (M is a transition metal, A an element of groups 13-16 and X is either C or N) [1,2]. Until recently, the difficulty to produce single crystals prohibited a thorough investigation of their physical properties. Our team found the way to produce such crystals [3-5], and this opened the door to new lines of research in a field which already triggers an intense international research activity. One of the emergent aspects is the development of a new class of two-dimensional ("graphene-like") objects called MX-enes by dissociation of the weaker A planes [6]. For some applications, these 2D systems require the use of single crystals, and we demonstrated that even bulk crystals exhibit a quasi-2D behaviour, resulting in a giant anisotropy of electron transport properties [2].

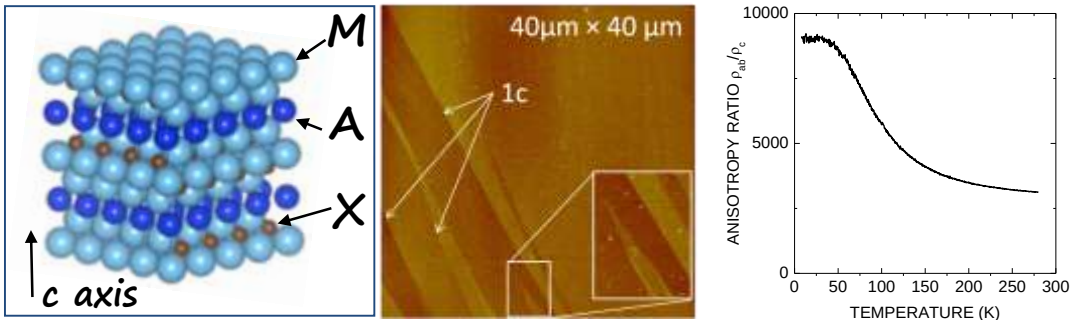

Fig.1 : *MAX phase structure (left), Atomic Force Microscope image of an atomically flat surface of Cr_2AlC with partial 2D exfoliation of the top layer (middle), and giant anisotropy factor of the resistivity of V_2AlC (right).*

Project

The project deals with the synthesis of new single crystals of nanolamellar carbides and with the study of their physical properties. Crystals will be synthesized at LMGP using the high temperature solution growth reactors already developed at the lab [2-4]. Devices will then be processed to assess the electrical transport properties at low temperature, or crystals will be used to measure de Haas van Alphen quantum oscillations of the magnetization (collaboration with LNCMI, Grenoble). Research is funded by an ANR national project called MAXICRYST.

Competences

Solid state physics and/or materials science. Fluency in French is not demanded but then a good working knowledge of English is mandatory. Depending on student's own inclinations, an accent can be put either on materials science aspects (crystal growth and characterization) or on physical aspects (electron properties).

Time and place

Possibly starting in Feb.2016 at LMGP.
Web site of the lab: http://www.lmgp.grenoble-inp.fr/

PhD possible : YES
Internship stipend : 554€ per month

Contact

Thierry OUISSE, Thierry.ouisse@phelma.grenoble-inp.fr, tel :0456529343

References

1. T.Ouisse & D.Chaussende, Phys. Rev. B **85**, 104110 (2012).
2. T.Ouisse, L.Shi, B.Piot, B.Hackens, V.Mauchamp & D.Chaussende, Phys. Rev. B **92**, 045133 (2015)
3. F.Mercier, T.Ouisse, & D.Chaussende, Phys. Rev. **B**, 83, 075411 (2011).
4. L.Shi, T.Ouisse, E.Sarigiannidou, O.Chaix, H.Roussel, D.Chaussende & B.Hackens, Acta Materialia **83**, 304 (2015)
5. T.Ouisse, E.Sarigiannidou, O.Chaix, H.Roussel, B.Doisneau & D.Chaussende, J. Cryst. Growth **384**, 88 (2013)
6. M.Naguib *et al.*, ACS NANO **6**, 1322 (2012)