PhD student in experimental physics: Surface structure and properties of quasicrystalline approximants in Au-Si-RE (RE=rare earth) systems.

Team 'Metallurgy and Surfaces'

Project description:

Quasicrystals, long-range aperiodic ordered systems, lack translational symmetry in 3-dimensions. With no unit cell, their structure is often best described in physical space by the assembly of highly symmetric atomic clusters. This same concept applies to the atomic arrangement for approximants periodic phases. The latter crystals have comparable composition and local structures to their quasicrystal counterparts/parents. Thus, Au-Si-RE (RE=Rare-Earth) approximants that will be studied in this thesis possess a structure close to the $MCd_{5.7}$ (M=Ca, Yb) quasicrystal built from Tsai-type clusters [1]. These building blocks consist of a series of concentric polyhedral shells [2] leading to a complex structure. This gives Tsai-type quasicrystals and approximants unique thermoelectric and magnetic properties which can be modulated according to the chemical decoration and the disorder within these atomic clusters [2].

Unlike for the bulk, the surface atomic structure and properties of these Au-Si-RE approximants remain unexplored until today. Several open questions will be addressed during the course of the thesis concerning the aggregate stability once exposed at the surface, the local arrangement of the different chemical elements, the electronic structure or even the magnetic properties of these complex surfaces. Here we propose to characterise the surface structures and properties of Au-Si-RE (RE=Rare-Earth) approximants at the atomic scale using experimental surface science techniques including low energy electron diffraction, scanning tunnelling microscopy along with photoemission and tunneling spectroscopies. For this, the PhD student will have access to two multi-technique ultra high vacuum (UHV) chambers and to experimental facilities available on the TUBE, an instrumental platform connecting twenty UHV systems for the development and characterization of material surfaces (https://ijl.univ-lorraine.fr/recherche/centres-de-competences/depot-et-analyse-sous-ultravide-de-nanomateriaux-daum/). These in-house studies could be completed by experiments on large scale instruments (Soleil, ESRF).

This thesis work will be carried out in close collaboration with our Swedish colleagues from the University of Uppsala who synthesize the Au-Si-RE (RE=Rare-Earth) approximant samples and are involved in the European network ECMetAC (https://ecmetac.eu/), consortium coordinating research on complex metal alloys at a European scale.

[1] A.P. Tsai, J.Q. Guo, E. Abe, H. Takakura and T.J. Sato, Nature 408, (2000) 537.
[2] G.H. Gebresenbut *et al.*, J. Phys.: Condens. Matter 26, (2014) 322202.

Your environment: The PhD work will mainly take place at the Institut Jean Lamour (IJL) in Nancy. IJL is a joint research unit of CNRS and Université de Lorraine and one of the largest research center in materials science in France, covering materials physics, metallurgy, plasmas, surfaces, nanomaterials and electronics. It benefits from exceptional experimental facilities and partnerships with both academics and private companies all around the world.

Salary: PhD contract from the University of Lorraine. 1769 € gross salary/month.
Duration: 3 years.
Starting date: October 2021
Application deadline: 2nd April 2021

Qualification requirements: Applicants should have a degree in a relevant physics, chemistry or materials science discipline. Knowledge in the area of intermetallics and/or surface physics and chemistry are favourable. A good knowledge of English (written and spoken) is required. Applicants should be able to work independently.
Applications including your full CV, academic records, publication list (if applicable), should be sent electronically.

Contacts:

Julian Ledieu (thesis advisor)
julian.ledieu@univ-lorraine.fr
Vincent Fournée (thesis co-advisor)
vincent.fournee@univ-lorraine.fr