Nano-Science and Applications of Intermetallic compounds

University of Liverpool, Department of Physics, Liverpool, United Kingdom

Funded PhD Project (European/UK Students Only)

Intermetallic compounds represent a relatively unexplored area of materials science and yet offer unique combinations of properties which are mutually excluded in conventional materials, such as electrical conductivity combined with low thermal conductivity. Our research involves the characterization of surface structure, electronic properties, reactivity, and growth of atomic and molecular overlayers on intermetallic compounds using microscopic and spectroscopic techniques. The experimental techniques used include scanning tunnelling microscopy (STM), low energy electron diffraction (LEED) and x-ray photoelectron spectroscopy (XPS). The intermetallics of interest are quasicrystals and binary intermetallics.

Quasicrystals possess aperiodic long range order often associated with crystallographically forbidden rotational symmetries and exhibit many outstanding physical properties. Our recent discovery of a range of quasicrystalline films of single elements [1] and molecules [2] have opened new opportunities to resolve several fundamental questions in the field, such as how the quasicrystalline order influences the physical properties of materials. The successful candidate will be involved in exploring the physical and chemical properties of the already discovered atomic and molecular overlayers, and in exploring the formation of new quasicryslline overlayers.

The candidate will also work on application-oriented areas. Intermetallic compounds can be potentially used as catalysts, because of their tuneable electronic properties and capability of tailoring of dispersion of catalytically active sites. One such catalytic reaction is the steam reforming of methanol, which is one of the most promising processes to provide hydrogen for mobile fuel cell applications. The objective of the proposed research is to use intermetallic compounds as model catalysts to investigate the catalytic reactions under ultrahigh vacuum conditions, and achieve atomic scale understanding of the catalytic reactions - which will help to optimise the reactions and ultimately develop novel catalysts for energy applications. This project is developed based on previous work within the group [3].

The candidate should have, or expect to have, at least a 2:1 degree or equivalent in Physics or Chemistry. The candidate will work under the supervision of Dr Hem Raj Sharma and Prof Ronan McGrath. The experimental works will be carried out in the Department of Physics of the University of Liverpool. However, the candidate will be provided the opportunity to perform experiments in the laboratories of our overseas collaborators, including member institutes of the European Integrated Center for the Development of New Metallic Alloys and Compounds (C-MAC). The successful candidate is expected to commence work from October 2017.

For more details contact Dr Hem Raj Sharma (H.R.Sharma@liverpool.ac.uk) and Prof Ronan McGrath (mcgrath@liverpool.ac.uk).

Applicants should be resident in the UK or the EU. The award will pay full tuition fees and a maintenance grant for 3.5 years (£14,296 pa in 2016/17).

[1] Sharma et al, Nat. Commun. 4, 2715 (2013).
[2] Smerdon et al, Nano Letters 14, 1184 (2014).
[3] Lowe et al, Journal of Chemical Physics 142, 094703 (2015)