





Job offer – Post-doctorate in synthesis of Heusler alloys for spintronic (For non-French scientists only)

Research Project Short Title as Submitted to CEFIPRA: "Novel spin-gapless semiconducting Heusler alloys for spintronics (SpinGapHA)" Principal Investigator contact (Name, Institution and email id): Eric Alleno, Institut de Chimie et des Materiaux Paris Est (ICMPE), eric.alleno@cnrs.fr Reference Number of the Job Offer: IFI_CEF_24_21

Project description

- **Keywords:** Spintronics, Spin-Gapless Semi-Conductor, Half-Metallic Ferromagnet, Heusler Alloy, Ab-initio calculations, galvanomagnetic transport
- **Context:** First-generation spintronic devices are characterized by high data processing speed and low power consumption. To increase their storage density, it is necessary to use materials with greater spin polarization. Half Metal Ferromagnets (HMFs), in which one of the spin sub bands behaves like a metal while the other spin sub bands mimic a semiconductor, are known to exhibit 100% spin polarization due to their unique band structure. HMF-based devices could "power" the next generation of spintronic hard disks or MRAMs. Like HMFs, Spin Gapless Semiconductors (SGS) combine a semiconductor spin sub band with a semi-metallic spin sub band. Not only do they feature very high polarization, but also high electron mobility, which further minimizes the energy required to operate devices that might incorporate them. SGSCs are therefore seen as a new class of materials, capable of powering a new generation of spintronic devices.
- Abstract of the Research Project: Ternary and quaternay Heusler alloys like Mn2CoAl, CoFeCrGa and CoFeMnSi belong to the family of compounds showing SGSC properties. They have a high Curie temperature and an adjustable electronic structure. However, SGSCs are very few and atomic disorder affects their electronic structure and reduces their spin polarization. This is why we propose to search for new quaternary Heusler alloys with an SGSC or HMF electronic structure and to study the effects of disorder on their electronic structure to better control them.
- Scientific objectives of the Project: The identification of new Spin-Gapless Semi-Conducting materials among Heusler alloys based on 3d-, 4d-, and 5d-metals is the main objective. Finding as well Half-Metallic Ferromagnets is another objective. These two classes of materials display the large spin polarizability required to design new spintronic devices. In both cases, research actions will be deployed to assess their ease of fabrication in a well-ordered crystalline structure.
- Methodology: The post-doc scientist will work on Heusler alloys in bulk form with new compositions. They will have been highlighted beforehand by machine learning algorithms combined with high-performance DFT calculations. These alloys will have been synthesized and characterized in the project's Indian partner research team (Professor C. Mazumdar, Saha Institute, Kolkatta). He/she will carry out further microstructural characterizations by X-ray diffraction and scanning electron microscopy. She/he will conduct differential scanning calorimetry experiments to highlight any structural transitions commonly observed in these alloys. He/she will participate in the drafting and implementation of neutron diffraction experiments (Institut Laüe-Langevin) or synchrotron X-ray diffraction experiments to characterize in detail any atomic defects encountered in these new alloys. If possible, he/she will participate in DFT calculations of the electronic structure. He/she will carry out measurements of electronic transport (resistivity and Seebeck coefficient) as a function of temperature and magnetic field (Hall effect and magnetoresistance) with the help of a CNRS engineer. The post-doctoral fellow will be responsible for highlighting the influence of composition and elaboration methods on the SGSC or HMF properties. She/he will write the publications produced by this research and communicate her/his results in conferences.







Laboratory: The post-doc scientist will work at Institut de Chimie et des Matériaux Paris-Est in Thiais (https://www.icmpe.cnrs.fr/en/) under the supervision of Eric Alleno (<u>eric.alleno@cnrs.fr</u>) and Céline Barreteau (<u>celine.barreteau@cnrs.fr</u>), both CNRS scientists (https://www.cnrs.fr/en).

Candidate profile

- Candidates can be all nationalities except French. In case of double nationality (French and another one), the candidate is not eligible. In the context of CEFIPRA, Indian candidates are preferred
- The candidate will hold a doctorate defended before 31/12/2024.
- No competence in French language is required but English language must be fluently spoken and written.
- The candidate will have a research profile in Materials Science (Materials Science or Solid-State Chemistry or Solid-State Physics), with experience in characterizing the microstructural and electronic transport properties of bulk inorganic materials, preferably intermetallics. He / she will have experience in powder X-ray diffraction, specifically in Rietveld refinements. He / she will also have experience in measurement of electrical resistivity and if possible, in implementation of empirical models to interpret this property. Experience in measurements of magnetic properties or DFT calculations is desirable but not mandatory.

Expected starting date: 1st June 2025 Duration: 12 months. Extensible by maximum 6 months

How to candidate?

Documents to be provided:

- i. A cover letter including reasons for candidacy, a summary of past research activities and professional project... (max 2 pages)
- ii. A copy of PhD degree or proof of followed PhD program including date of defense (max 1 page)
- iii. A copy of results of previous scholarship (max 3 pages)
- iv. International curiculum vitae including a list of publications (max 2 pages)
- v. Two letters of recommendation: one from any Indian institution and one from the French institution planned to host the candidate mandatory (max 2 pages
- vi. All should be submitted within 1 pdf file of no more than 10 pages.

Applications should be submitted to the following email address: msi@ifindia.in.







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Candidates are requested to contact the French scientific principal investigator of the project before submission. A recommendation letter from the scientific principal investigator is mandatory.

Benefits:

- Monthly allowance of 2400 euros for Post-Doc
- Travel allowance
- Carte de séjour fee
- Campus France management fee
- Registration to the French social security scheme

Selection process

Selection is made by a dedicated selection committee of 4 persons (2 members of the Embassy of France in India and 2 external experts). Decisions will be transmitted to CEFIPRA. <u>No consideration will be given for candidates with no</u> recommendation letter from the French institution.

Criteria for applicant's selection:

Academic excellence

• Excellence of the academic background, academic records, honors, letters of support, participation to international research projects, exchange programmes and conferences.

Motivations and qualities

• Academic maturity: appropriation of the project (stakes and contexts). Quality of the presentation (expression, skills for synthesis, English level). Maturity of the professional project: capacity to project: capacity to project her / himself within five years in terms of career development.

About CEFIPRA:

Indo-French Center for the Promotion of Advanced Research (CEFIPRA / IFCPAR) is an Indian body which promotes scientific cooperation between France and India in advanced fields of Science and Technology. It is upported by the Department of Science and Technology, Government of India and the Ministry of Europe and Foreign Affairs of the French Government.