Uncovering Fundamental Mechanisms to Enable Sustainable Steel Manufacturing

PhD Studentship

Supervisors: Dr Zushu Li, Professor Sridhar Seetharaman (WMG), and Mr Koen Meijer (Tata Steel Europe)

Industrial sponsor: Tata Steel Europe

Funding: Stipend of circa £14,000 per year

Start date: As early as possible

Project overview:

This project aims to generate fundamental knowledge related to interface reactions for a novel low energy, low carbon process for producing iron.

The steel industry is facing significant challenges in achieving and sustaining competitiveness, such as strict environment regulations, new energy sources, global overcapacity, and competition from other materials. In particular for the European steel industry, the EU target of the 80-95% reduction in CO₂ emissions by 2050 is far beyond the reach of the steel sector. To create an industry that will be sustainable for the future, extraction of metals needs to be lean in energy, low in C footprint and flexible with regards to raw material sources.

The HIsarna process is a promising alternative to blast furnace iron making and was conceptualised as part of the EU ULCOS consortium aimed at reducing CO₂. This breakthrough technology is currently undergoing most active development by a group of partners led by Tata Steel. There is a clear need of a detailed understanding of the reactions taking place in this novel low energy, low carbon process.

This PhD will elucidate the critical scientific mechanisms underlying the low energy, low carbon alternative iron making process. The aims of the research are as follows:

- To carry out experimental study of the reactions in the gas-metal-slag systems at high temperatures. This includes the reactions of thermal coal, its volatile matter/natural shale gas, biomass, and the resulting gas mixtures of CO, H₂, and CO₂ etc with iron oxides in smelting slags.
- To elucidate the reaction mechanisms and rates of the reduction of FeO in smelting slags by various reducing agents (gases of H₂, CO, etc and various types of solid carbon).
- To perform experimental investigation on the behaviours of metal droplets in smelting slags using a high temperature confocal scanning laser microscope and computerised x-ray micro-tomography technique.
- To conduct detailed examination of the samples by means of SEM and by means of thermodynamic analysis at both WMG and Tata Steel.
The project provides an outstanding opportunity to be involved in cutting edge research of next generation sustainable steel manufacturing, and also gives valuable exposure to a major area of industry - Tata Steel both in the UK and in the Netherlands - by working closely with industrial sponsor.

Entry requirements

Qualifications
Candidates should have a minimum of an upper second (2.1) honours degree (or equivalent) in Materials Sciences (including Metallurgy, Ceramics), Chemical Engineering, Chemistry, Geology or related disciplines.

Attributes
- High levels of innovative thought and lateral thinking
- Excellent analytical and reporting skills
- Excellent communication skills
- Self-motivated, capable of working with minimal guidance and supervision, and within a team
- Enthusiasm for the subject

The Studentship
Qualifying students will receive a stipend of circa £14,000 per year. Due to funding regulations this project is open to Home/EU students only.

The funding is for three years and will also cover University tuition fees and all course fees, as well as a travel allowance to attend courses.

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