Leslie Comrie Seminar Series 2023/24

Wednesday 21 February 2024, 15:00-16:00

Speaker: Dr Qingwei Bai, Helmholtz-Zentrum Dresden-Rossendorf Technische Universität Dresden, Germany (Currently visiting Centre for Advanced Simulations and Modelling, University of Greenwich)

Title: Grain refinement and segregation zone modification under a pulsed electromagnetic field

Abstract:

The development of the metallurgical industry was one of the outstanding achievements of the Industrial Revolution in the 18th century, making it possible to increase iron output, as well as to reduce production costs and the prices of metal products for consumers. Today, centuries later, the challenges in industrial production have shifted towards low carbon emissions, the pursuit of sustainability, and the emphasis on high quality products. As an illustration of aluminium alloy production, the energy consumption and greenhouse gas emissions of primary aluminium are 144612 MJ/t_{Al} and 14.772 t $CO_{2\text{-}eq}/t_{Al}$, respectively, while the recycled aluminium is only 6.37% and 4.45% of the former value. However, Due to the mixture and/or accumulation of the tramp element at each remelting cycle, which have the tendency to segregate during solidification and precipitate into harmful intermetallic compounds even at small volume fractions to downgrade the material properties.

Electromagnetic technology is a solution to manipulate impure elements to form finely dispersed crystal morphology and relieve segregation by improving the solute migration and temperature gradients in solidification rather than the ’naturally’ occurring coarse and brittle compounds. This process is as crucial as stirring instant coffee with a spoon, but how to utilize non-contact electromagnetic fields to control high-temperature liquid melts remains complicated because of its high dependence on solidification.

In the first part of this presentation, I will introduce the industrial applications of electromagnetic fields and the challenges associated with them based on FEM models for solving Maxwell's equations. Subsequently, I will elaborate on our current solidification experiments in Diamond Light Source (UK's national synchrotron science facility) and its quantitative image processing.

Biography:

Dr Qingwei Bai is a joint postdoctoral researcher at Helmholtz-Zentrum Dresden-Rossendorf (HZDR)/ Technische Universität Dresden in Germany and the University of Greenwich in UK. He received Ph.D. degree in Metallurgical Engineering as a joint doctoral candidate between SIMaP/EPM Lab/French National Centre for Scientific Research (CNRS) and Inner Mongolia University of Science & Technology in 2018. Subsequently, He served as a lecturer and researcher at Inner Mongolia University of Science & Technology in China until 2022.

Dr Bai has been funded as principal investigator in 3 Chinese government projects. In 2022, he won highly globally competitive DAAD funding project in Germany. He is youth committee member of China's renewable resources industry technological innovation strategic alliance. He has served as a peer reviewer in Metallurgical and Materials Transactions B, Materials & Design, scientific reports, et al., and has published over 18 peer reviewed papers and 7 patents.

His research interests revolve around magnetohydrodynamics (MHD) and metal solidification under electromagnetic fields, with a dedicated focus on applying electromagnetic fields to the metallurgical industry using FEM simulation technology. He possesses broad multidisciplinary research interests encompassing electromagnetism, metallurgy, engineering as well as quantitative image processing related to dendrite growth and solute migration.