Exploring deformation mechanisms of materials at small length using in-situ micromechanical testing – its relevance to additive manufacturing

Abstract: Failures in structural materials primarily occur as a result of stress concentrations at microstructural features, such as at grain or phase boundaries or precipitate interfaces. Micromechanical testing of materials at scales comparable to microstructural features and subsequent evaluation of mechanical response can provide direct insights into the deformation mechanism of materials fundamental to their inherent structure. Using an in-situ diffraction technique employing white x-ray beam, called micro-Laue diffraction in conjunction with micromechanical testing, such as nano-indentation or micropillar compression allows understanding fundamental plastic deformation behavior of materials. Also time-resolved pattern acquisition during the test gives an idea of the temporal evolution of strain gradient and deformation structure within materials. Micro-Laue diffraction use sub-micron sized beam to gain high-resolution three-dimensional information from the small, constrained sample volumes. In this talk, I will be presenting cases to establish the versatility of this approach to extract critical information on the deformation mechanism on a spatio-temporal scale in various material classes. Finally, the relevance of such micromechanical testing philosophy to large-scale additively manufactured components would be discussed.

Biography

Dr Ayan Bhowmik is currently a Research Fellow in the School of Mechanical and Aerospace Engineering (MAE) at Nanyang Technological University, Singapore. He obtained his Bachelor’s degree from Jadavpur University and Masters from the Indian Institute of Science, Bangalore, India in Materials Engineering. Following that he received a Dorothy Hodgkin Postgraduate Award to carry out doctoral studies at Rolls-Royce University Technology Centre in the Department of Materials Science and Metallurgy, University of Cambridge. Following PhD, he continued in Cambridge as a Research Associate, simultaneously having been appointed as a Junior Research Fellow (member of the governing body) in Darwin College. He then worked for three more years as a post-doc Research Associate in the Department of Materials, Imperial College London before joining the Manufacturing and Repair Technology team of Rolls-Royce@NTU Corporate Lab in School of MAE.

Over the years, he has worked on a variety of research areas within the broad scope of structural materials which includes exploring and evaluating new alloys for next generation turbine engines, understanding the micromechanical behavior of materials using in-situ experiments and developing a mechanistic understanding of component repair by cold spray coatings. However, one common thread connecting the interests is the multi-scale understanding of the processing-structure-property relationship in engineering materials.