Seeing Materials Through a Synchrotron Looking Glass:
Inside Additive Manufacturing to Intact Covid-19 Injured Organs with Micron Resolution

Peter D. Lee and many collaborators
Assistant Director, Physical Sciences, Research Complex at Harwell
Prof. of Materials Imaging, University of Manchester
Harwell Science & Innovation Campus, Didcot, OX11 0FA, UK
peter.lee@manchester.ac.uk

Whether manufacturing an orthopaedic joint replacement or an Airbus 380, a number of different engineering components are assembled as a system, with each component requiring demanding structural or functional requirements. To achieve these requirements, each component has a hidden world of internal structure, ranging from the nano to micron scale. This nano/micro-structure provides strength, toughness, and functional properties. As material scientists, we tailor these complex internal nano/micro-structures to obtain the best performance, working with mechanical engineers to design macroscopic component shape and function. This talk will describe the new tools *synchrotron imaging tools* that are being developed, such as 4D X-ray imaging (3D plus time), and how they can be applied to better understanding microstructural evolution, enabling us to develop materials with improved structural and functional properties.

Using aeroengine components as the first example, we will demonstrate how combining fast radiography (e.g. 50kfps) and 4D synchrotron X-ray imaging and unique nano-precision process replicators to capture the phenomena in the weld pool during additive manufacturing (AM) and then to determine the components failure mechanisms.

Using the techniques developed for aerospace applications, we will then look inside the heart of a volcano, capturing the behaviour of magma as it flows, crystallises, and initiates vesiculation on a beamline.

Finally, we'll demonstrate how, using the brilliance and coherence of the ESRF-EBS upgrade to become the first higher energy 4th generation synchrotron to probe with micron resolution how COVID-19 causing injury inside of whole organs.

Biography

Peter holds the Royal Academy of Engineering Chair in the Emerging Technology of Additive Manufacturing. He is a Professor of Materials Science at University College London, but his group is based at the Research Complex at Harwell, where the UK's Synchrotron, Neutron and Laser sources are located. His research focusses on the computational simulation and X-ray imaging of materials at a microstructural level. He was one of the pioneers of multi-scale and through process modelling (now termed ICME), working at Alcan on the prediction of defects in light alloy components for companies such as Ford and Rolls-Royce. Peter is an avid experimentalist, developing nano-precision rigs that replicate the processing and service performance of materials on synchrotron beamlines, enabling us to see inside materials in 3D as they change in time. He has developed a series of additive manufacturing machines (both powder bed and Directed Energy Deposition blown powder) that work on synchrotron beamlines at Diamond Light Source, ESRF and APS. His work is revealing how microstructures evolve in processes ranging from additive manufacturing to volcanic eruptions to microstructures within the to microstructures within the human body. His experimental techniques and open-source codes have been exploited internationally by aerospace, automotive, energy and biomedical companies to solve important engineering challenges – from developing additive manufactured human joint replacements to aerospace components.
See "Peter D Lee Google Scholar" or his home page for publications.