Located at the School of Materials at the University of Manchester, the Henry Moseley X-ray Imaging Facility houses a suite of six computed tomography (CT) systems. "Worldwide academic and industry researchers have access to top-class equipment that offers full resolution and length scale capabilities for samples ranging from heavy engineering items to micron-sized biological specimens," says Professor Phil Withers, founder and Director of the X-ray imaging facility. "Evaluating stunning 3D models reconstructed from a series of X-ray images revolutionizes many research fields, including materials science, biology, mineralogy, paleontology, entomology, medicine and life science."

About dinosaurs and other animal specimens

The Henry Moseley X-ray Imaging Facility is shedding light on a diverse range of natural samples. Recently, fossilised portions of ungual claws of
failure mechanisms in composites is a tricky business, knowing that the damage often remains largely invisible externally until late in the testing process. X-ray and CT technology help gain a better understanding of the failure mechanisms and develop mathematical formulae describing the degrading performance characteristics.”

At various stages throughout the fatigue process, the composite samples are investigated in the walk-in radiation bay of the unique Nikon Metrology 320kV microfocus X-ray system. Such voluminous parts easily fit in the large cabinet bay, which is equipped with a fully programmable 5-axis manipulator designed for samples up to 100kg.

The X-ray source is a proprietary 225/320kV microfocus source with a spot size that is considerably smaller than competitors’ mini-focus sources, providing image resolution up to 3 microns.

CT is critical in studying composites failure mechanisms

According to Chris Martin, another growing research activity concerns new lightweight materials gaining popularity, particularly for aerospace applications. He mentions current research projects to develop and exploit in-situ rigs to enable multi-mode stressing of composite samples — a keen interest of the international aerospace companies the School of Materials collaborates with. “Identifying

Stunning 3D Computer Tomography models revolutionize many research fields, including materials science, biology, mineralogy, paleontology, entomology, medicine and life science.

Professor Phil Withers, Founder and Director of the Henry Moseley X-ray Imaging Facility at the University of Manchester
Increasing productivity and pushing the limits of CT technology

“To maximize CT infrastructure availability for fundamental research and commercial projects, we decided to operate the facility 24/7,” says Professor Phil Withers. “To free up CT equipment after data capture, the X-ray data is automatically transferred to a central cluster of computers, which handles the reconstruction of the 3D models from a series of X-ray images. This guarantees maximum productivity, while local reconstruction resources remain available in case of failure.”

“Equally important is that we try to push the limits of CT technology by focusing on the optimization of the reconstruction software. We benefit from strong programming expertise present at the University of Manchester, and have active academic links with Nikon Metrology and other CT specialists. Detailed insight into our own reconstruction software allows us to optimize data acquisition and precisely figure out how to interpret 3D Computer Tomography models.”

“Both our micro-CT systems from Nikon Metrology respond to a broad range of academic and industrial applications. The systems’ high accuracy, large field of view and fast image acquisition are well appreciated. Our experience with these systems is that parties applying CT for a specific purpose generally discover more purposes for this enabling technology. We are currently expanding the imaging facility to further explore the nano length scale, in order to provide an even wider range of possibilities.”

A premium 2000 x 2000 pixel Perkin Elmer flat panel detector accurately digitizes cracks and fractions formed in the composite material, within a 400x400mm field of view. “Superior X-ray technology is needed to get sufficient contrast, as composite parts are low-density by nature and absorb different energies in different directions,” Chris Martin concludes.

A similar approach is applied to study metal corrosion mechanisms that occur in nuclear reactors or chemical plants. CT observations provided insight into the development of corrosion pits, stress corrosion cracks and their geometries, to improve system design and deduce mathematical formulae. When dealing with metal and other dense materials, the system can be equipped with a rotating target source. Such a source generates an X-ray flux that is up to 5 times higher without risking permanent source damage, providing faster data acquisition and/or higher image accuracy.

Chris Martin says that the Nikon Metrology 225/320kV inspection system also supports dynamic investigations. Its walk-in radiation bay provides sufficient space to install instrumentation to study how specimens evolve over time, either naturally or under a range of loads, temperatures or other stimuli. A triaxial loading cell, for example, can be used to monitor the evolution of voids, inclusions, fractions and disturbances in large rock and soil samples. For the inspection of smaller parts, researchers at the imaging facility use a similar, yet more compact 225kV CT inspection system from Nikon Metrology.