Micro- and Nano scale in situ X-ray CT as a Diagnostic for Material Performance

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X-ray tomography is often used pre and post experiment to understand damage in materials. One current ‘hot topic’ in materials science is additive manufacturing. In 3D printed polymeric materials, the interfacial strength between the printed layers can destroy any designed mechanical performance long before a cast material of identical geometry. Without understanding these interfaces, 3D printing will never move beyond printing toy dinosaurs and into the realm of high performance materials. In situ measurements of the mechanical performance, as well as ex situ imaging of broken parts can be used to help understand which aspects of printing determine overall mechanical strength. Even more complicating, printing direction and conditions, which vary from manufacturer to manufacturer also affect performance.

X-ray microscopy of materials on the nano-scale is critical to understanding the relationships between processing, structure, and performance. Interestingly, this technique, when coupled with a load stage, can be used to understand crack propagation along interfaces. For example, the uniaxial tension of Al-Cu alloys, when imaged on the nano-scale, break along the Al and Al-Cu rich interface. The crack propagation will even change directions to follow this pathway. Compression of single crystal materials, such as high explosive HMX, can be used to better understand crystal fracture growth.