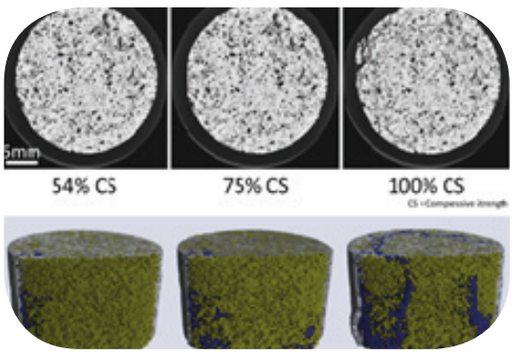
Using µXCT/XRM in-situ tensile/compression testing stages - CT5000

In-situ testing stages provide an immediate interpretation of how the properties of materials and composites change under different loading and temperature conditions. Deben have developed a range of tensile/compression and cooling sub-stages to work with the most common µXCT & XRM systems.

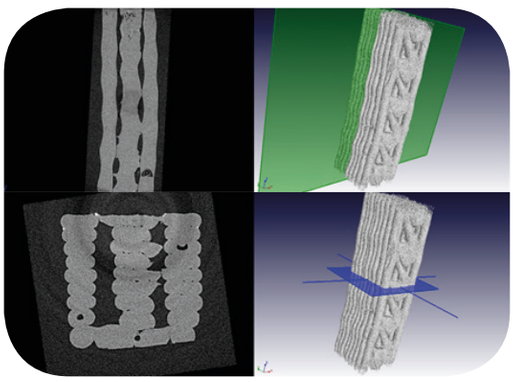
3D X-ray microscopy facilitates quantitative understanding of microstructure under both ambient and in-situ environmental conditions. This enables imaging and tomography of microstructures as well as observation of micro and nano-structural evolution under a variety of conditions.

In association with the major manufacturers of µXCT systems including Zeiss, Nikon, GE and Bruker, Deben offers an integrated tensile testing solution for µXCT applications. Tensile testing with µXCT provides a clear visual interpretation of how the properties of materials change under different loading conditions. The compact design of these testing stages allow them to be used with the smallest high resolution micro CT systems providing a range of tensile, compression and torsion stages with forces up to 20kN and resolutions down to 25mN. Variable temperature options enable users to work from -20°C up to +250°C. There are also options enabling work in liquid and in an environmentally controlled chamber.

Many different materials may be studied using µXCT & XRM. These range from teeth and bones to complex advanced composites. Deben stages may be found in laboratories worldwide. Here, we look at a range of practical applicators.



Rock specimens under increasing compressive load



3D CT scans at 40 N show the internal structure of the central section of the tensile sample. The brighter grey is plastic and black is air. The 3D view with plane shows the orientation of the 2D slice view to the left.

Geology:

The Centre for X-ray Tomography at Ghent University investigates dynamic processes in geomaterials related to different research fields such as fluid flow behaviour, fracture nucleation and propagation in rocks. Led by Professor Veerle Cnudde, the group use a Deben CT5000 stage. "It is one of the few systems which are highly adaptable to the needs of individual test cases. It allows different set-ups to be made according to the requirement of the experiment. Important in our research is that it can reach the high loads necessary for rock samples to be broken."

Composites:

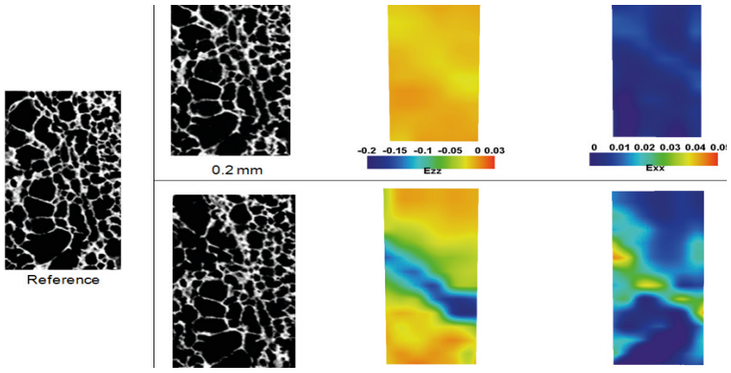
Natural and man-made composites may be studied using Deben in-situ X-ray CT tensile and compression stages. The multi-user CT Scanner Facility at Stellenbosch University in South Africa serves academia and industrial clients. Facility Manager, Dr Anton du Plessis has looked at a wide range of materials. An interesting example involves the study of samples of polymer (ABS) generated by 3D printing. Testing has shown it is possible to visualise the exact internal point of failure under tension.

Dr du Plessis said "the ability to non-destructively visualise materials using an in situ stage before and after processing (e.g. compression or pulling) allows researchers to visualise the microstructural details inside their samples under load for the first time."

The Deben CT5000 tensile system mounted in a Nikon CT X-ray Inspection System at the University of Portsmouth.

Biological scaffolds:

It is important to know how materials and components respond to complex loading conditions and how micro-structural properties dictate global material or structural responses. Professor Jie Tong of the Mechanical Behaviour of Materials group at the University of Portsmouth uses the CT5000 5kN in-situ loading stage with a µXCT from Nikon to examine how a biomaterial (scaffold) behaves under compression and its failure modes.



Local strains (right) in a 2D section of a scaffold, computed using CT images (left) from the reference and at compressive displacements of 0.2 mm and 0.5 mm. The sample was compressed along the loading direction. Localised deformation in Ezz along a 45° direction is evident at 0.5 mm displacement.

Ghent PhD student, Jeroen Van Stappen, loads a rock sample into the Deben CT5000 stage mounted on one of the scanners of UGCT

CT5000 Summary:

- 5kN Tensile and compression testing stage for CT Tomography systems
- 360° clear line of site through specimens
- Simple specimen exchange mechanism
- High strength glassy carbon support tube, 60mm diameter
- Tensile/compression clamps and flat compression platens
- Exchangeable loadcells, 500N, 2kN and 5kN.

CT5000 Versions:

- Room Temperature only system
- TEC Heating and cooling system -20°C to +160°C
- H250 Heating only system, Ambient to +250°C
- Water bath system for compression while submersed in liquid

Contact Deben to discuss your µXCT experimental requirements. Using their comprehensive MICROTEST tensile stage control software with its wide range of control functions and a live display of load versus extension, stages are supplied with all required cabling and mounting adaptors for specific µXCT systems.

Acknowledgements: Deben would like to thank the following users for their comments on the use of the stage and to allow reproduction of these applications images.

- Professor Veerle Cnudde, Ghent University: http://www.pprogress.ugent.be/index.php#home
- Professor Jie Tong, University of Portsmouth: http://www.port.ac.uk/school-of-engineering/staff/prof-jie-tong.html
- Dr Anton Du Plessis, Stellenbosch University: http://blogs.sun.ac.za/ctscanner/introduction/

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