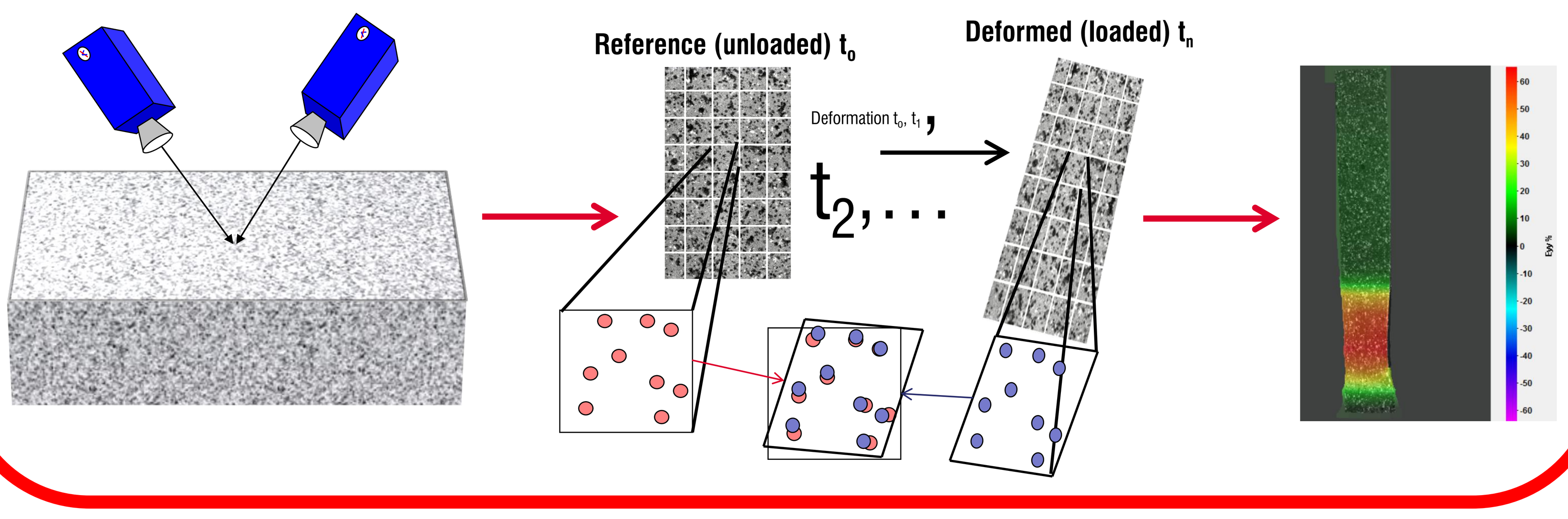
DIC and DVC for Strain and Crack Investigations

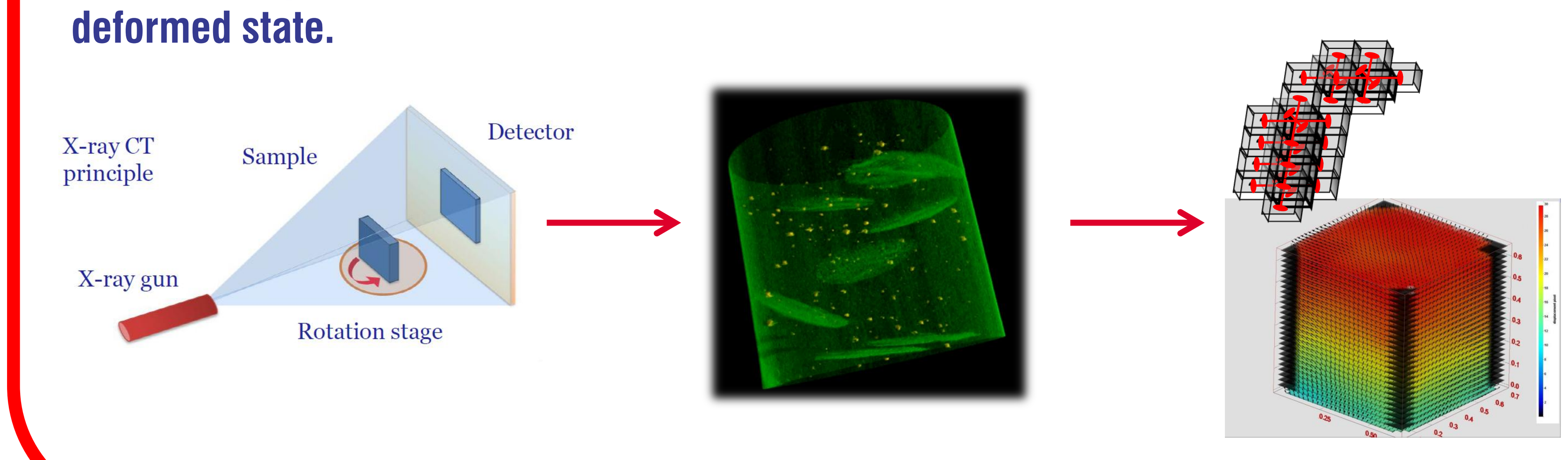
LaVision

Introduction

• Digital Image Correlation (DIC) is a technique that uses images of the surface of materials to calculate displacements that have occured between a reference and some deformed state. From the displacement results strain derivatives can be calculated and dsplayed on the sample surface as a full field data map.

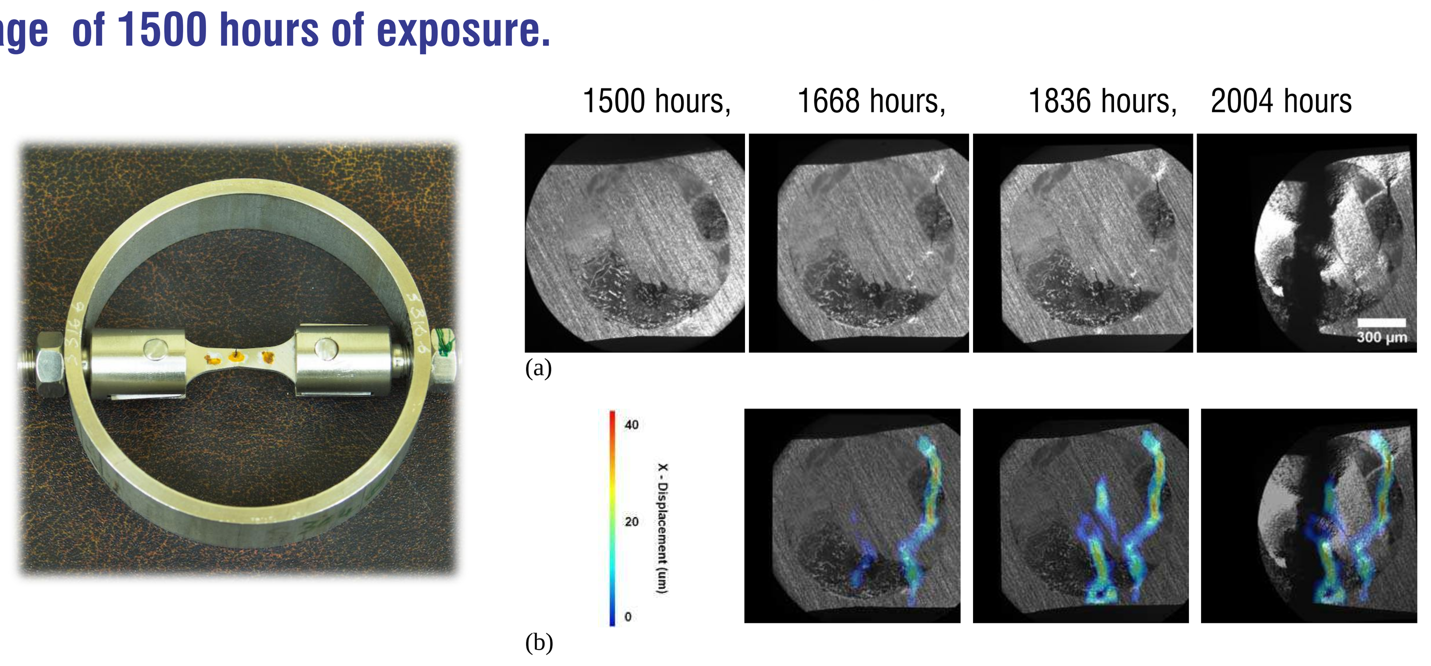


• Digital Volume Correlation (DIC) uses 3D volume images of materials created by X-Ray CT scanners, Magnetic Resonance Imaging (MRI), or any other system capable of generating volumetric images. The reconstructed volume images are then used to calculate displacements and strains that have occured between a reference and some deformed state.



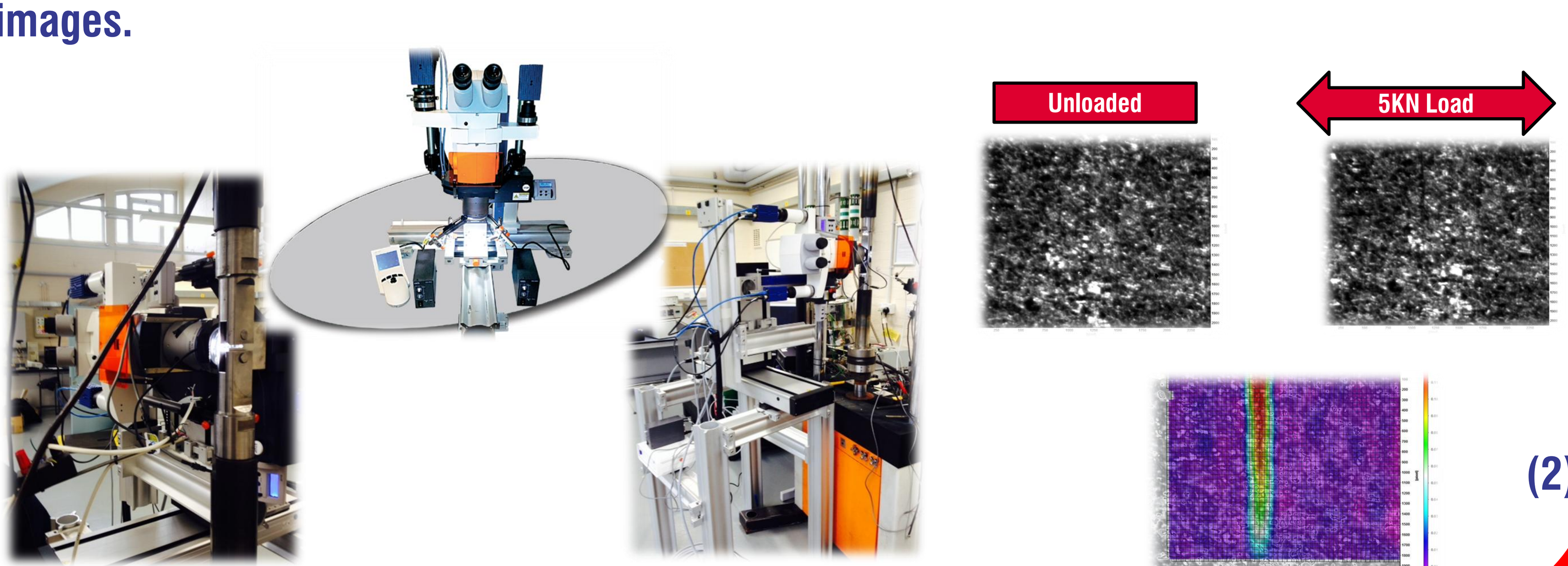
DIC for Crack Investigations

• DIC was used to study stress corrosion crack nucleation in austenitic stainless steel beneath a chloride salt deposit (under a tensile static stress). Raw images are shown above strain maps (calibrated to show crack opening displacements) relative to first image of 1500 hours of exposure.



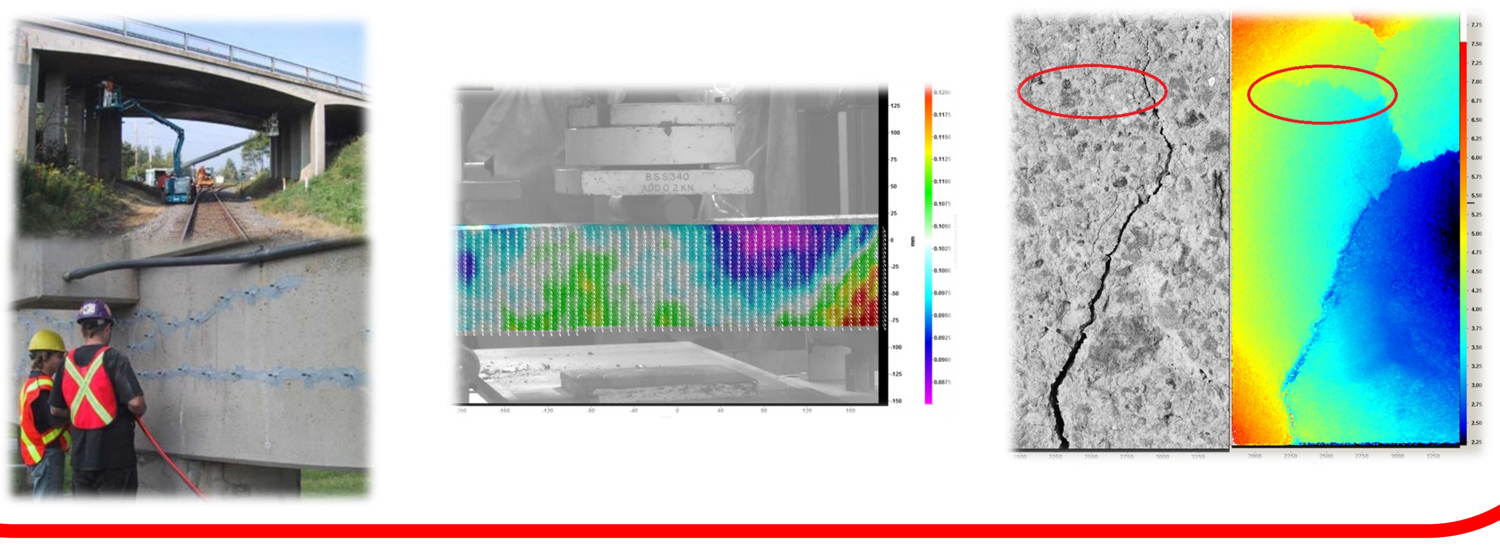
(1)

• High magnification stereo DIC on a stainless steel sample. Exaggerated levels of strain are displayed to identify the crack location and track its movement along the specimen. The sub pixel accuracy available through the Least Squared Matching (LSM) correlation approach allows cracks to be identified when not obviously identifiable in the raw images.



(2)

• Macro scale DIC was conducted on a concrete beam subjected to a three point bend loading process. Ultra high spatial resolution was achieved by using small subset sizes. Whilst small subsets have lower precision, they give higher spatial resolution, enabling the goal of accurate crack location detection. The highlighted red region shows areas where cracks would not normally be identifiable in the raw image but become obvious when studying the strain data

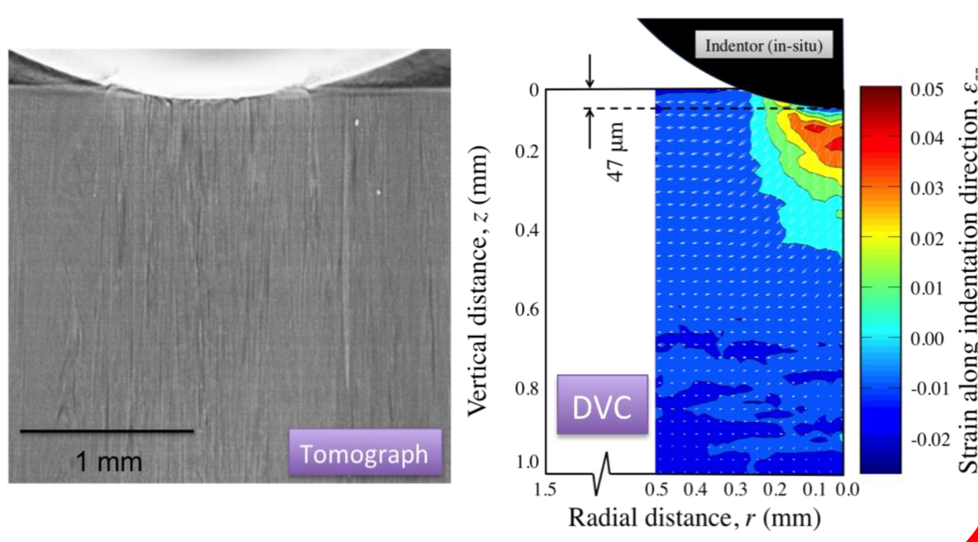


(3)

DVC for Crack Investigations

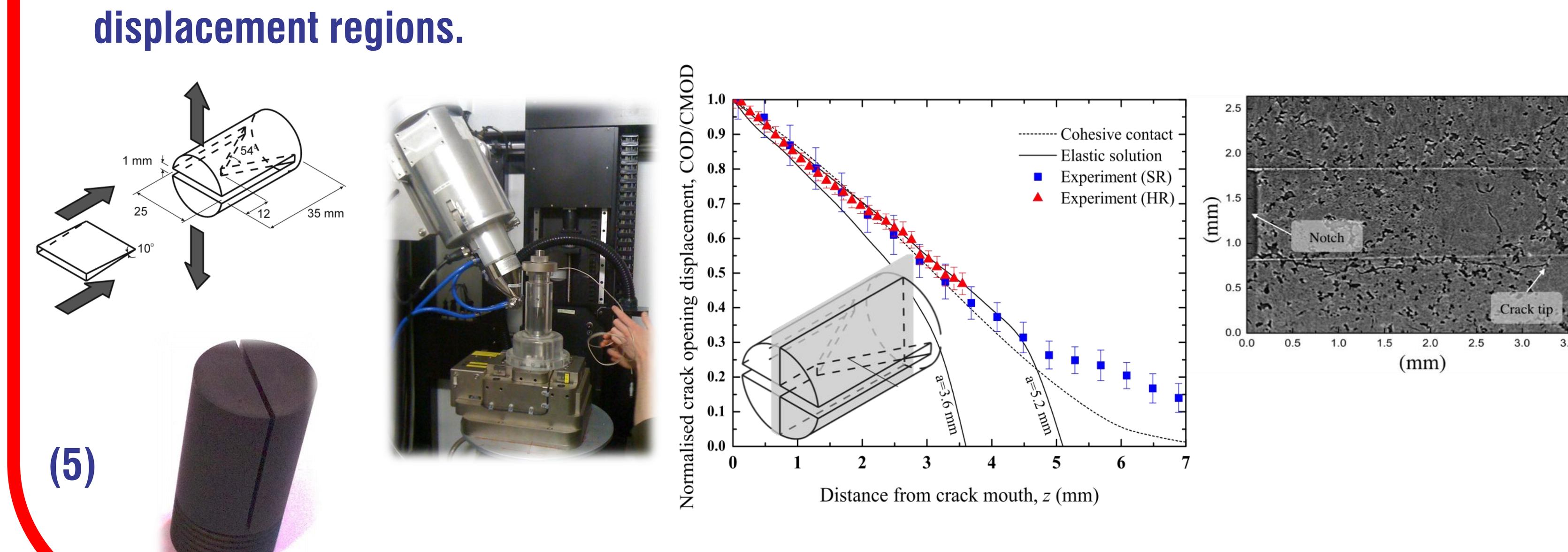
• DVC in conjunction with μCT images to study the deformation processes occurng beneath the suface of an an aluminium-silicon carbide composite, when indented with a 5 mm radius ZrO2 ball, with an in situ loading rig. The example below shows the vertical section of the μXCT data of the Herzian indention. The DVC-measured vertical strain is shown as a contour map (right) with vectors of the displacement field superimposed. Apart from close to the indentation, the displacement field and the reaction force agree well with an elastic-plastic FE simulation of the indentation, using the measured indentation depth and properties from tensile tests of the same material

(4)



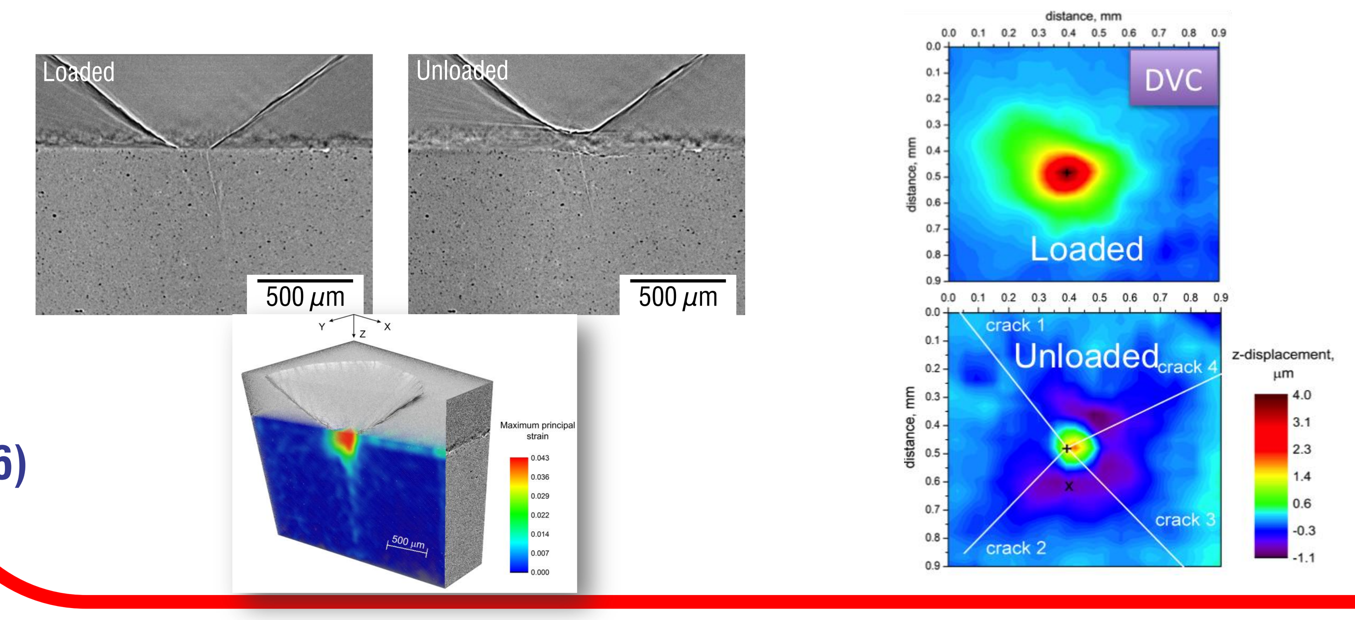
• A notch sample of nuclear graphite was scanned during loading. DVC was then used to identify displacements, strains and later a 3D crack opening displacement (COD). This study highlighted a high strain region ahead of the apparent location of the crack tip, designated as the 'Fracture Process Zone' where microcracks are shown as additional displacement regions.

(5)



• Vicker's indentation of Al_2O_3 ceramic showingtomographic vertical cross-sections of sample under load and unloaded. The corresponding figure maps the maximum principle strain. On the right maps of vertical displacements in a horizontal plane under the indentation, showing the indentation deformation and the uplift from lateral cracking. The radial cracks are indicated.

(6)



All studies were conducted using LaVision's StrainMaster. For more information visit www.LaVision.com

(1) University of Manchester - doi: 10.1149/1.3407553 ECS Trans. 2010 volume 25, issue 37, 119-132
(2) Unpublished data - Images acquired by LaVisionUK Ltd
(3) 3 Point bend test conducted at National Physical Labs (NPL), UK
(4) University of Oxford – 3D studies of Indentation by combined X-ray tomography and digital volume correlation. Key Eng. Mater. 592-593 14-21
(5) University of Oxford - DOI: 10.1016/j.actamat.2013.07.011
(6) University of Oxford – 3D studies of Indentation by combined X-ray tomography and digital volume correlation. Key Eng. Mater. 592-593 14-21