Biomaterials: Deformation and Strain

Digital Image Correlation: A powerful solution for deformation and strain measurements in micro scales of biomaterials

Introduction

Scientists and engineers in Biomaterials research are facing many challenges. One of them is that many specimens are very small and sensitive, therefore it is extremely difficult to measure their deformation and strain.

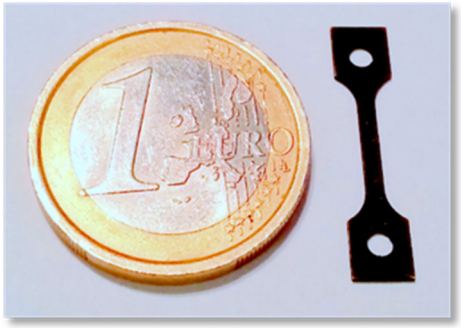


Image 1 – Example of microscale tensile probe

The Digital Image Correlation (DIC) technology, however, has successfully been applied to these applications.

Application Examples

A Q-400 µDIC™ system from Dantec Dynamics was successfully used in tensile test of micro specimen made of titanium used for hip implant after fatigue lifetime test. Results included 3D map of displacement and strain, Modulus, Poisson Ratio and other results.

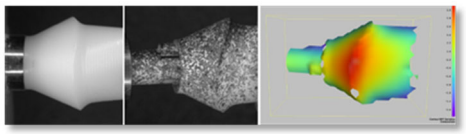


Image 2 - µDIC™ was used during compression fatigue test of dental implant to characterize strains at different zones (implant, abutment and crown)

Trabecular bone (Lat. substantia spongiosa ossium) structure during compression test

The experiment was performed in order to obtain strain values of individual trabeculae to calculate their Young's Modulus and improve the FEM model of the bone. These microscale measurements are used to correctly predict macroscale interaction between bone and implant.

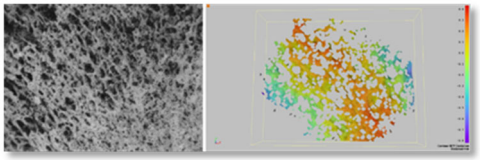


Image 3 - Trabecular bone structure during compression test

Shear test of polyurethane

Shear test of polyurethane with special coating is used in production of artificial heart valves. The values of strain measured by µDIC™ were similar as tested by in situ SEM (scanning electron microscope) micro shear test and calculated by FEM (Finite Element Method) model for the same values of load and displacement.

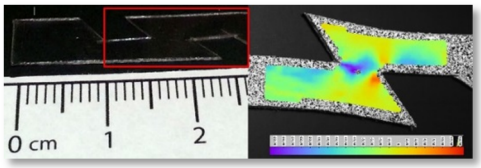


Image 4 - Shear test of polyurethane used for producing artificial heart valves

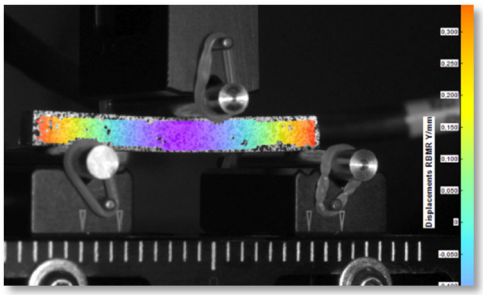
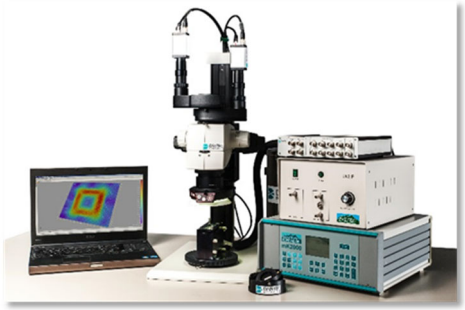


Image 5 - Three point bend test performed on micro specimen of cortical (hard) bone. Results present Y displacement during maximum load.

Optical measurement solution

As a specialist for optical surface measurement, Dantec Dynamics offers a range of solutions based on Digital Image Correlation (DIC). The method is based on a pattern recognition on the specimen to be



observed, the so-called "speckles".

Image 6 - Dantec µDIC™ system with TCT option

Dantec Dynamics' Q-400 µDIC™ system is an optical measuring instrument for true full-field, non-contact and three-dimensional analysis of displacements and strains on biomedical materials and components in microscale. It can be used for many tests including tension, compression, torsion, bending and combined loading, peel, creep, relaxation as well as many others on a wide range of biomaterials. µDIC™ opens new field of research for micromechanical characteristics of ultra-small and sensitive materials. High measurement sensitivity and accuracy are prerequisites to measure deformation induced not only by direct mechanical loading but also by thermal loading, changes of humidity, and by physiological factors.

Benefits of Dantec Dynamics' optical measurement system

- Real-time 3D image correlation of shape, deformation and strain with sub-micron accuracy
- Fast setup and focusing making measurements of micro specimens easy
- Easy and fast FEM validation, mechanical properties characterization and CTE determination
- Auto calibration for quick and efficient setup of the measurement system

Q-400 µDIC™ in brief

- 3D shape, deformation and strain measurement in application areas like:
  - Biomaterials
  - Medical device components
  - Orthopedic devices
  - Implants
  - Soft tissues
  - Bone microstructure
  - Dental materials
  - Surgical micro tools
  - Wood microstructure
- Optical, non-contact measurement method
- Fast, accurate online visualization of results
- Small, microscopic samples from 17 x 17 mm² to 0.5 x 0.5 mm²
- All-in-one system with mechanical and thermal load (as an option)
- Calculation of mechanical moduli, Poisson ratio, CTE and many others

DANTEC DYNAMICS Turn Measurements into Knowledge

Application Note_368_v1

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