

Development of Mechanical Testing system and Reliability Evaluation for Biomedical Materials and Micromaterials

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1 Reliability Evaluation of UHMWPE for Artificial Knee Joint

Ultra High Molecular Weight Polyethylene (UHMWPE)

Advantages

Superior mechanical properties; Good wear resistance, low friction co-efficiency

High chemical resistance: bio-compatibility

Application example

Bearing materials in artificial knee joints

Artificial Knee Joint

Life time of polyethylene plate is about 10-20 years
Patients need another operation for replacement.



Fatigue Testing



Specimen of UHMWPE



Evaluation of Fatigue Crack Growth Behavior

3 Development of Electrospinning Method for Tensile Test of Single Nanofibers

Nanofiber

Larger surface area to volume ratio than the Conventional Microfiber
Molecular Chain Aligned in the Fiber: Good Mechanical Properties

$$\text{Nano means } \dots$$

$$1\text{nm} = \frac{1}{1000} \mu\text{m} = \frac{1}{1000000} \text{mm}$$

Electrospinning Method (Manufacture of Nanofibers)



Nanofiber Electrospinning Unit

Applying High Voltage to Polymer and Electrospinning Targets

Advantage : Spinning at room Temp.

Direct spinning

Controllable of fiber shape



PLA Nanofibers



This machine measures the load & displacement in nano order



Nano tensile®

PLA (Poly lactic acid)

- Made from Natural Resources
- Biocompatibility
- Melting Temp.: 180 °C

SCPLA (Stereocomplex-type PLA)

- Optical Isomer: D- and L-poly lactic acid
- Stereocomplex
- Melting Temp.: 230 °C

Tensile Test of a Single Electrospun Nanofiber

2 Mechanical Properties of Amniotic Membrane

Regenerative Medicine

Creating tissues to replace the damaged one



Amniotic Membrane

Amniotic Membrane (AM)

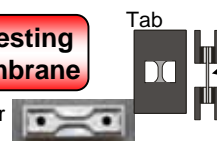
The innermost layer of the placental membranes
Thin, Transparent Tissue, Free from Vascular component

Expected to be used for substrate in regenerative medicine

Development of Tensile Testing Method For Amniotic Membrane

- Handling

Cutter



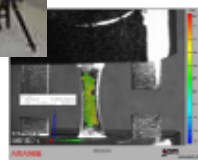
Tab

Amniotic membrane

- Strain measurement



Non-contact Optical 3D Deformation System (GOM mbH, ARAMIS)



According to the image correlation method by having a sprayed pattern on specimens

4 Mechanical Properties of Cancellous Bone

Cancellous Bone

Light, porous bone enclosing numerous large space, also called spongy bone
Bone turnover occur faster than cortical bone --> index for osteoporosis

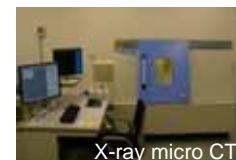


Evaluation of Mechanical Properties and Microstructure of Trabecular Bone

Microstructure observed by X-ray micro CT
Bone

Parameter (Trabecular number, Trabecular direction, and so on)

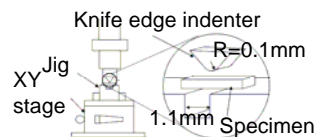
Compression Test
Three Point Bending Tests of Single Trabecular Bone



X-ray micro CT



Compression Test



Knife edge indenter

XY Jig

stage

R=0.1mm

1.1mm Specimen