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14. ABSTRACT
This award was used to acquire an Instron ElectroPuls E3000 (EP) for Mechanical Testing. This is an electrodynamic instrument for slow static tests and high-frequency dynamic fatigue testing for materials such as polymers, nanocomposites, metals for microelectronics, and soft materials. It can be used to perform tests such a tensile, compressive, fracture, fatigue, and flexural in a large range of materials and components, and a variety of environmental conditions. The accessories include an environmental chamber for fatigue testing in air to temperatures up to 250°C, a liquid nitrogen cooling unit for tests to temperature down to -100°C, and a bio bath for

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Report Title

Final Report: Acquisition of an Instron Electropuls E3000 Instrument for Mechanical Testing

ABSTRACT

This award was used to acquire an Instron ElectroPuls E3000 (EP) for Mechanical Testing. This is an electrodynamic instrument for slow static tests and high-frequency dynamic fatigue testing for materials such as polymers, nanocomposites, metals for microelectronics, and soft materials. It can be used to perform tests such a tensile, compressive, fracture, fatigue, and flexural in a large range of materials and components, and a variety of environmental conditions. The accessories include an environmental chamber for fatigue testing in air to temperatures up to 350°C, a liquid nitrogen cooling unit for tests to temperature down to -100°C, and a bio-bath for the testing of hydrogels, biological tissues, polymer films, and metals in a temperature range from ambient to 40°C. A standard video extensometer and software to measure strains at micro-level without specimen contact are also included in the system. The installation of the system at the Soft Matter Characterization Laboratory located in the Chemical Engineering building was completed in January 2015. Basic and advanced training ended in March 2015. The EP will support research in nanotechnology, materials science and engineering, and bioengineering the Departments of Chemical, General, and Mechanical Engineering, and Chemistry as well.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:...... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:...... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):...... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:...... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:...... 0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

See Attachment

Technology Transfer

SUMMARY

The acquisition of the ElectroPuls E3000 is fundamental for the development of novel materials at UPRM in structural and bioengineering applications as well. As stated in the proposal, 7 research projects of faculty members from the Departments of Mechanical Engineering, Chemical Engineering, General Engineering, and Chemistry at UPRM will immediately benefit from the acquisition. These ongoing research projects require determination of mechanical properties of a wide variety of materials under demanding ambient conditions. Based on this base user group it is estimated that more than 9 graduate students, 15 undergraduate students, and 2 high/middle school teachers, will benefit immediately from the acquisition of the EP. The Instron ElectroPuls E3000 Instrument for Mechanical Testing, will allow room for expansion of research interests and collaboration with other researchers interested in mechanical behavior in general, as well as the particular applications listed below.

The projects that have priority in the use of the equipment are:

1. Development and Testing of Magneto-Thermally Healable Polymer Nanocomposites for Structural Applications; B.O. Calcagno (Department of General Engineering).
2. Composite Liquid Crystalline Elastomers for Sensing Applications; A. Acevedo, B.O. Calcagno (Departments of Chemical and General Engineering).
3. Fabrication of Wires Treated with Diboride Nanoparticles; O.M. Suárez (Department of General Engineering).
4. Solder Based Nanomanufacturing Using Three Dimensional Nanotemplates; R. Valentín (Department of Mechanical Engineering).
5. Bone Regeneration using Biomimetic Peptide-Hydrogel Scaffolds; J. E. Ramirez-Vick (Department of General Engineering).
6. Dynamic strain response of Type I collagen fascicles under cyclic loading; P. Sundaram (Department of Mechanical Engineering).
7. Factors Influencing Formation or Inhibition of Protein Amyloid Fibrils in Hydrogels; S.P. Hérnandez-Rivera (Chemistry Department).

Summary of On-going tests

Composite Liquid Crystalline Elastomers for Sensing Applications (one graduate student, one undergraduate student)

Liquid crystalline polymers and their elastomers are structurally anisotropic materials capable of changing their mechanical and optical properties, amongst others, when exposed to applied external fields (flow, electric or magnetic) or due to molecular binding events at their interfaces. Responsive composite LCEs with chemically functionalized magnetic nano-particles have been created (MLCE). Their dynamic response to an external magnetic field is been investigated to find the coupling amongst internal structure and mechanical performance, which provides information on particle-matrix compatibility and adhesion, orientation, dispersion, and stress propagation mechanisms. Mechanical properties of these novel materials are been determined using dynamic and tension tests with a video measurement system for accurate determination of strains. (See Fig. 1 and 2)

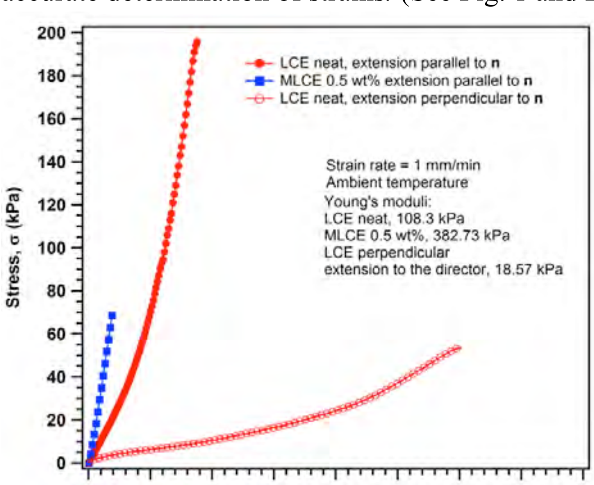

Figure 1. Stress-strain curves for neat LCE, and MLCE with 0.5w/o with stress applied along the director (n), and for neat LCE with stress applied perpendicular to the director. Young moduli for all of them are included in the graph.

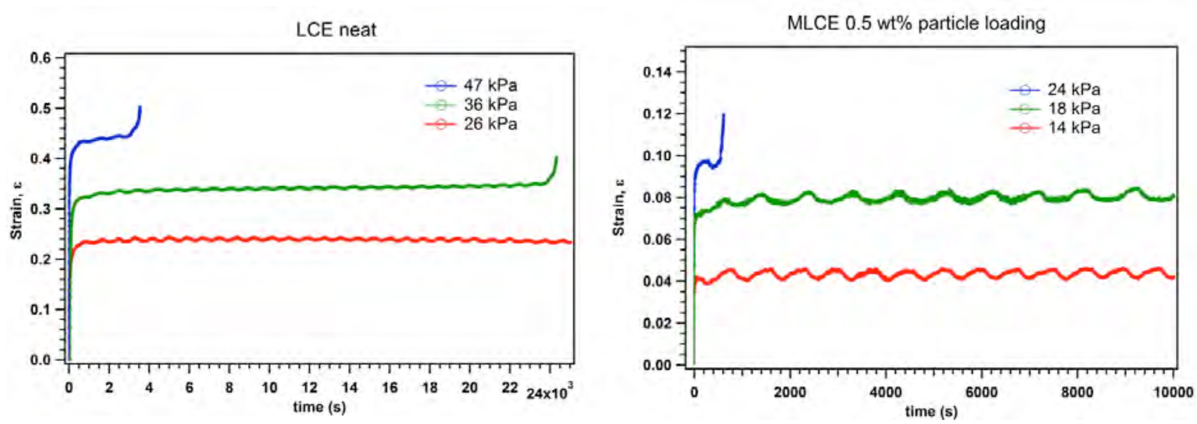

Figure 2. Creep curves for LCE neat and MLCE with 0.5w/o particle loading at various stresses applied along the director.

Dynamic strain response of Type I collagen fascicles under cyclic loading (One undergraduate student)
The goal of this project is to determine the strain response of collagen in the form of Type I fascicles obtained from rat-tail tendons under dynamic loading conditions. A controlled tensile sinusoidal load function will be applied to sample fascicles and the corresponding strain response will be measured over a frequency range of 0.1 Hz to 2.5 Hz which covers the physiological range of many cyclic human activities. The viscoelastic behavior of the fascicles under sinusoidal tensile loading will be characterized in terms of models developed specifically to explain the observed results.
Fatigue tests of fascicles from rat-tail tendons have been done under load control (0.4 ± 0.3 N) at 0.5, 1, 2.5 and 5 Hz (see Fig. 3)

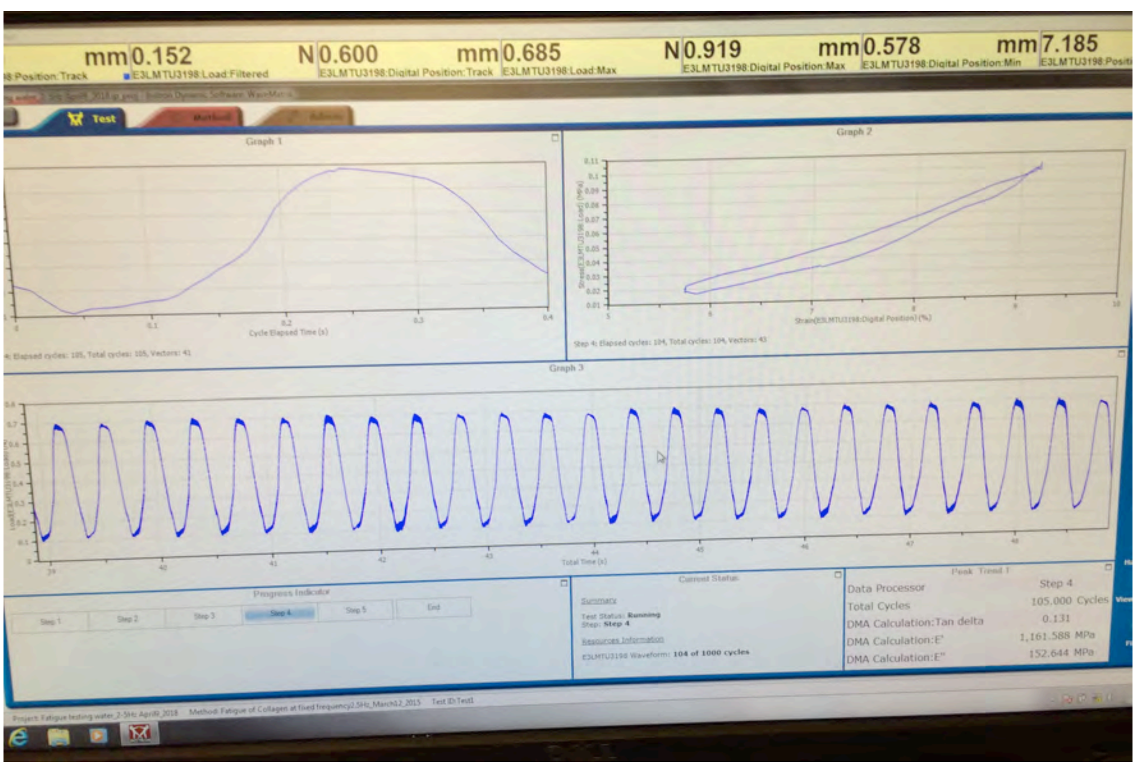

Figure 3. Snapshot of an ongoing fatigue test at 2.5 Hz.

DESCRIPTION

	PRICE
ElectroPuls E3000 All-Electric Dynamic Test Instrument, Dell Precision T3400 PC, 19" flat screen monitor. Includes load frame, linear motor, displacement and force transducer set, advanced digital controller and Console software, WaveMatrix Software for Fatigue Testing and Bluehill Materials Software for Static Testing. It has a dynamic capacity of 3kN and 2,100 N static capacity, and Two Self-identifying Load Cell (250 N & 10 N). On-site hardware installation, and training, ASTM Load Cell Calibration, and Displacement and Speed Calibration. Post Installation Sales Engineer Visit	$122,000
High stiffness support table, and Safety guard made of polycarbonate .	$8,290
Pneumatic grips and fixtures (ambient temperature): (1) ±3 kN pneumatic fatigue-rated wedge action grips; (1) fatigue adaptors to use these grips with the 250 N load cell; (1) flat serrated jaw faces 25 mm wide for flat specimens; (1) vee jaw faces for round specimens; (1) pneumatic air kit to control the pneumatic grips; (2) compression anvil (10k N); (1) Dynamic extensometer for direct strain measurement; (1) Flexure fixture, 3-point bend, capacity 5 kN; (1) Thin film grips and adaptors; (1) Fiber clamps; (1) Wire snubbing grip	$22,580
BioPuls Bath and Accessories for use with distilled water or saline solution with accurate control of bath temperature at 37°C. Submersible grips and compression platens (250N).	$20,000
Environmental Temperature chamber supplied with digital temperature controller, observation window, removable wedges with temperature range from ambient to 350°C. Cooling module with a temperature range down to -100°C.	$22,000
Manual Fatigue grips for use inside temperature chamber (3kN, 250°C)	$15,800
Video Extensometer and BlueHill software with mounting brackets. Includes a Firewire digital camera, electronics, and accesories	$26,000
Fracture Mechanics grips and software (3kN capacity)	$17,800
Total Equipment Cost	**$254,470**
One day of advanced training (8 hours)	$1,755
Installation cost for upgrade of facilities (compressed air)	$483.93
Total Project Cost	**$256,708.93**

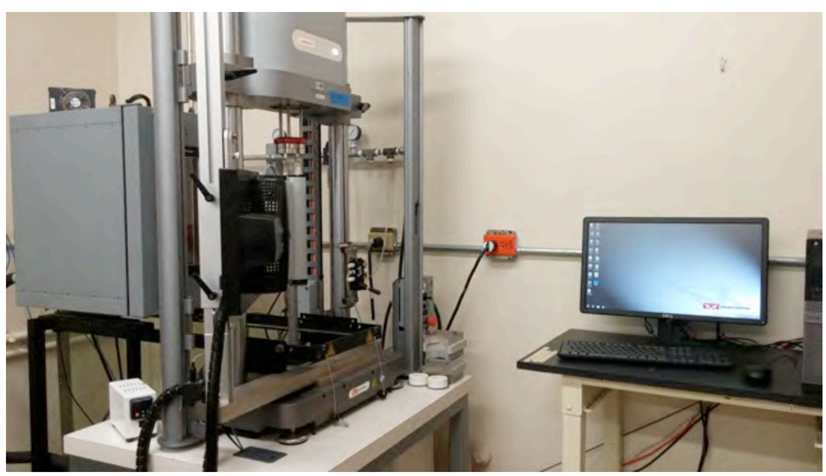

Figure 4. Images showing the Instron ElectroPuls E3000