

Modulating Cell Behavior on Piezoelectric Poly(L-lactide) Films

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Abstract

PZ-Active PLLA (PZLA): A biomaterial for cell alignment

Poly(L-lactic acid) (PLLA) is a completely bioresorbable polymer and is utilized in many biomedical and pharmaceutical applications, eg- as implant coatings, in drug delivery schema, and as biodegradable sutures.

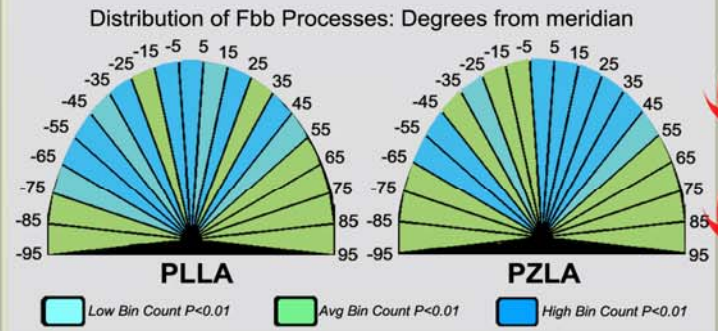
By simple uniaxial stretching, PLLA can be rendered piezoelectrically active (PLLA → PZLA), a property which may be utilized for cell alignment and enhance proliferation *in vitro*.

Such an easily synthesized cell guidance cue may prove advantageous in guided cell outgrowth applications such as spinal cord injury repair.

Herein we report on several material analyses and *in vitro* assays. Results suggest that PLLA can be rendered PZ-active for the enhancement of cell alignment, while exhibiting a similar degradation profile to that of traditional PLLA.

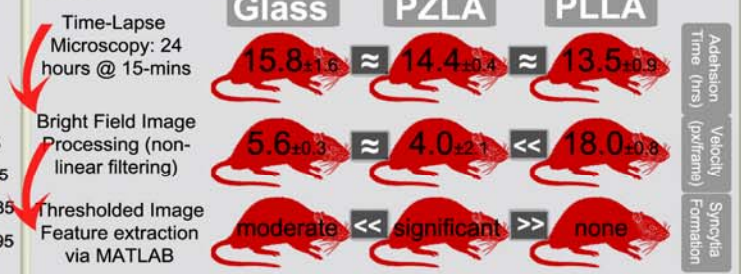
Fibroblast Processes Aligned on PZLA films

Mouse GFP-expressing fibroblasts were seeded onto externally activated PZ-active PLLA (PZLA) films and (stimulated) control PLLA films.



PZLA: comparable cell adhesion, enhanced proto-tissue formation

SV40-Transformed rat mesangial cells were seeded onto PZLA (3.5:1), PLLA (1:1), and glass controls. Adhesion time was comparable between cases.



Syncytia (proto-tissue) formation was greatest on PZLA films

Simple Uniaxial Drawing is Sufficient to Render PLLA Piezoelectric

Rheological Measurements



PZLA films were drawn to 2:1, 3:1, and 4:1 (final length : original length).

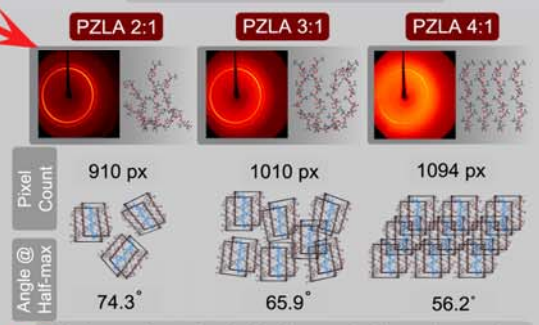
Films drawn 3.5:1 were compared to PLLA (undrawn) for their piezoelectric and dynamic mechanical properties.

13 Samples PZLA; 3 Samples PLLA
 10 Hz cyclic loading @ Room Temperature

PZLA exhibited similar mechanical properties to PLLA, as well as dielectric constant but produced vastly greater current per unit strain.

PZLA films were found to have increasing crystalline content and crystallite size as draw increased.

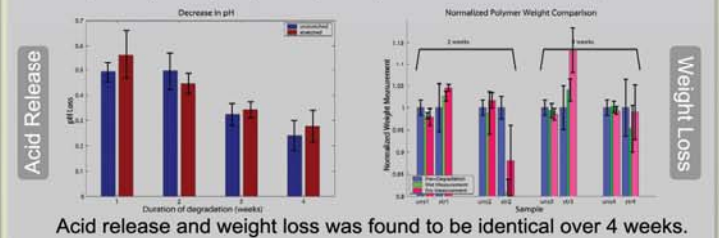
X-Ray Crystallography



Pixel count from thresholded images indicates increasing crystal content with draw. Similar half-angle width shows the increasing crystallite size with draw.

PZLA, PLLA: comparable degradation

PZLA and PLLA films were evaluated for their degradation *in vitro* in pH-adjusted (weekly to pH=7.4) Phosphate Buffered Saline @ 37°C.



Acid release and weight loss was found to be identical over 4 weeks.

Acknowledgements

NSF IGERT: Integratively Engineered Biointerfaces (DGE 0333196)
 New Jersey Center for Biomaterials Summer Research Award Grant