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# A MECHANICAL ANALYSIS OF BIODEGRADABLE NANOCOMPOSITES FOR ACL REPLACEMENT MEDICAL DEVICE

**Viviana Correia Pinto[1(*)], José Xavier[2], Artur Pinto[3,4], Fernão D. Magalhães[3], Rui Miranda Guedes[5]**
[1]INEGI, Faculty of Engineering, University of Porto, Porto, Portugal
[2]CITAB, University of Trás-os-Montes e Alto Douro, Vila Real, Portugal
[3]LEPAE, Department of Chemical Engineering, Faculty of Engineering, University of Porto, Porto, Portugal
[4]INEB, University of Porto, Porto, Portugal
[5]Department of Mechanical Engineering, University of Porto, Porto, Portugal
[(*)]*Email:* vpinto@inegi.up.pt

## ABSTRACT

Attending to the evolution in Tissue Engineering, choosing appropriate materials to each tissue, according biocompatibility and mechanical functionality is a challenge, especially in anterior cruciate ligament (ACL) replacement, when tearing occurs. With the purpose of finding artificial solutions for ACL, it is presented a mechanical study of nanocomposites of biodegradable polymers, in particular polylactic acid (PLA), reinforced with graphene and phosphate based glass. This preliminary study intends to characterized the material with static mechanical tensile tests and to determine if these are mechanical suitable for ACL replacement. Subsequently tests during degradation of the material will take place to understand its response during ACL recovery.

***Keywords:*** anterior cruciate ligament, ACL, tissue engineering, polylactic acid, PLA biodegradable polymer, nanocomposites, graphene, glass P40.

## INTRODUCTION

The evolution of materials used for anterior cruciate ligament (ACL) ruptures replacement has been remarkable, currently emerging from a cooperation between Mechanical and Tissue Engineering. Regarding this application, there is a growing research for synthetic solutions to replace the autografts, the most chosen by clinicians, but with limited availability. Hence, the purpose of this work is to project a medical device which presents functional, mechanical and biological compatibility suitable for ACL replacement that could fit as support during their recovery while simultaneous promotes their regeneration (Duthon, 2006).

Resorting biodegradable polymers, namely polylactic acid (PLA - PLA Ingeo® 2003D, Natureworks LLC, EUA), already approved by FDA for clinical use, composites reinforced with nanoparticles of graphene (GNP - graphene nanoplatelets grade M5, medium diameter of 5 μm and thickness between 6 and 8 nm, from XG Sciences, Lansing®, MI, EUA) and particles of glass P40 (phosphate based glass, (Parsons, 2010)) were made (nanocomposites PLA/GNP and composites PLA/PBG). These reinforcements intend to improve mechanical characteristics of PLA (Vieira, 2009), in particular mechanical resistance to fatigue, preventing laxity or rupture of the device (Bernardino, 2010).The composites specimens were produced in thin films of 0.3 mm thickness, by melt blending, followed by compression moulding in a hot press. They were made in a dog bone format, with a gauge length of 10x80 mm. It was also produced several weight compositions of reinforcements, namely 0.5, 1 e 2 %wt., for each composite. For this study mechanical tensile tests were made up to film rupture. These were carried out in an Instron 5848 Microtester machine under displacement control at a rate of v = 1 mm/min. The load was measured by means of a load cell of 2kN (gain = 250 N). It was used non-contact optical measurements, by Feature Tracking Method (Xavier, 2009).

## RESULTS AND CONCLUSIONS

For analytical purposes, stress ($\sigma$) versus strain ($\varepsilon$) plot is constructed as well as relation between strain in two directions ($\varepsilon_1$ and $\varepsilon_2$). Some results from a single tensile test are presented in Fig. 1, with Young's modulus and Poisson ratio determination.

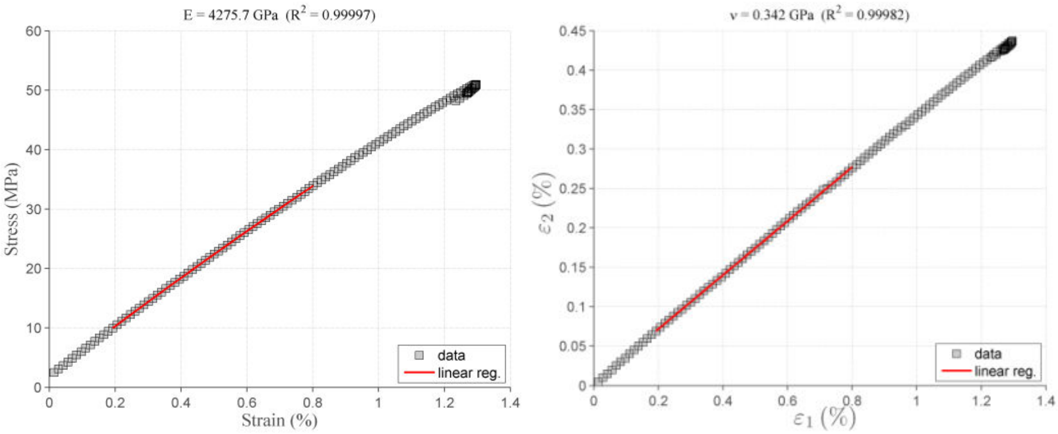


Fig. 1 - Tensile test results for PLA thin film

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