

Measurement of biocompatible polymers. Assessing technical properties and modelling their environmental impact relationships for new innovative Decathlon products

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Life Cycle Assessment (LCA)

Machine Learning

Gantt









Dynamic Mechanical Analysis (DMA)

Life Cycle Assessment (LCA)

Machine Learning

Gantt











How can the substitutability of **biopolymers** be

• Mechanical Characterization

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1222-2022

Environmental Characterization

### **DEC4THLON**

Machine Learning











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This is a measurement technique used to study **the viscoelastic properties of polymers** and involves the application of an oscillating force on the object to be studied in order to monitor the resulting deformation.



### **DMA Illustration**





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- 1) Young Modulus
- 2) Storage and Loss Modulus
- 3) Damping Factor

### **DMA Illustration**





In presence of a completely **elastic material,** deformation and stress are in phase (with an angle equal to **0**°).

In the case of a completely **viscous material** stress and strain, which do not overlap, occur at different times, and have a phase difference of **90**°.



### Elastic and Viscous Modulus Phase





In a viscoelastic material, the phase is between 0° and 90°. From the examination of the viscoelasticity of a material, we derive the modulus of conservation (E') and loss (E'') which measure respectively the energy stored at the time of deformation and that dissipated in the form of heat.







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#### Temperature (°C)





### The Glass Transition Temperature (Tg) is the temperature at which the polymers undergo the transition from Glassy to Rubbery state

Below  $T_g$ : Polymers are hard and brittle like glass, due to lack of mobility Above  $T_g$ : Polymers are soft and flexible like rubber due to some mobility Above  $T_g$ : Physical and mechanical properties of polymer change









# The measurement of complex modules is a key measure for the selection of the appropriate material

For example, the ability of a material to return to its original shape after load action affects performance during typical running





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### Life Cycle Assessment (LCA) is an analytical and systematic methodology that assesses the environmental footprint of a product or service, throughout its entire life cycle.





### **LCA Phases**

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Impact assessment









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DMA and LCA are measurement techniques that have been used for a long time.

## Where is the innovation?



to chose <u>a priori</u> which bio-polymer use for a certain kind of product

- LCA
- ...

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Weight







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				FIRST YEAR											S	ECC	ND	ND YEAR					тн			lird	RD YEAR						
WBS	TASK TITLE	% OF TASK		<b>T1</b>		1	T2		тз	3		T4		Т1			Т2		тз			т4		T	L		Т2			гз		Т4	
NUMBER		COMPLETE	0	Ν	D	J	F	MA	• м	IJ	J	Α	s	D N	D	J	F	MA	м	J	J	Α	s o	N	I D	J	F	м	Α	м ј	J	Α	s
1	First level: Study of two measurement techniques and polymers and polymers information																																
1.1	Information retrieval of polymers	15%																															
1.1.1	Find information on the distribution of these materials within the Decathlon's processes and products	15%																															
1.2	Dynamic Mechanical Analysis (DMA) tests	0%																															
2	First level: Data Analysis																																
2.1	Determine the correlation among tests data, their applicability on products and the environmental impact (direct due to recyclability and indirect due to the production of CO2 measured with TECO) in their use according to the based on the substitutability factor.	0%																															
3	First level: Machine Learning																																
3.1	Design of automatic methods for choosing optimal material for application	0%																															
4	First level: writing thesis																																
4.1	Writing Thesis	0%																															

# Thanks for the attention



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