



Bio-charge Elastic Characterization for A Qualitative Perspective of Innovative Bio-Composite Materials

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Abstract:

In order to save natural resources, recycling necessarily becomes a top priority for all of us, to save exhaustible resources, produce green energy and preserve the environment.

In this perspective, we are trying to valorize a waste of animal origin, largely neglected by the actors of materials, through an industrial transformation into a biological charge to make new sustainable bio-composite materials.

Using a tensile test bench, we try to mechanically characterize this biomaterial of renewable resources that, unlike eco-composites, has been neglected by the material actors.

Obtained from waste, with a high recycling potential and from renewable resources, the bio-charge to be analyzed will be injected, later in different polymer materials in order to support the evolution of their physicochemical properties: resistance to elongation, wear, heat, corrosion, etc.

Consequently, we will be able to contribute to an eco-design of sustainable materials with safeguarding exhaustible resources and preserving our environment

Keywords: Biological load, Natural resources renewable resource biomaterial, Physicochemical properties, Sustainable bio-composite materials

1. INTRODUCTION

Since 1992, Kohmei Halada defined the éco-materials [1-2] as materials contributing to the reduction of the environmental impact related to the human activities. This concept takes all its direction in the context of sustainable development and éco-design. They can be innovating materials or original known material combinations: Materials containing less dangerous substances, materials resulting from renewable resources, the coproduced industrial ones [3].

The last projections concerning the questions of materials of origin organic or inorganic, vegetable or animal or hybrids took a step of giant in making of “durable materials”. It will be necessary to take into account the use of natural resources and renewable as well on the level of the matrices as of the loads (natural, vegetable loads...) for composite applications by privileging the physicochemical properties. On the basis of these recommendations, we hope, through our subject of research, to make an improvement to these eco-composites by reinforcing their thermo-mechanical qualities by a load of animal origin.

One indicates under the general name of load any inert substance, added to a basic polymer, allows to modify in a significant way the mechanical properties, electric or thermal, to improve the aspect of surface or, simply, to reduce the cost price of transformed material. For a given polymer, the choice of a load is given according to the modifications searched for the finished object. But, generally, the substances usable as loads of the plastics will have initially to satisfy a certain number of

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requirements: Compatibility with the basic resin, absorptivity, uniformity of quality and grain size, weak abrasive action, low cost price...

This work primarily tries to profit from the physical performances of the virgin biomaterials naturally noted in order to increase the performances of unquestionable composite materials such as hardness, tenacity, impact strength, the heat strength... and to characterize this new eco-composite once organically-charged. This organic-load of animal origin is presented in the form of sheath regular thickness and generally smooth surface. It is finer at its base than at its end. The lower part is rough surfaces of them and present scratches with rather regular intervals "Figure-1".

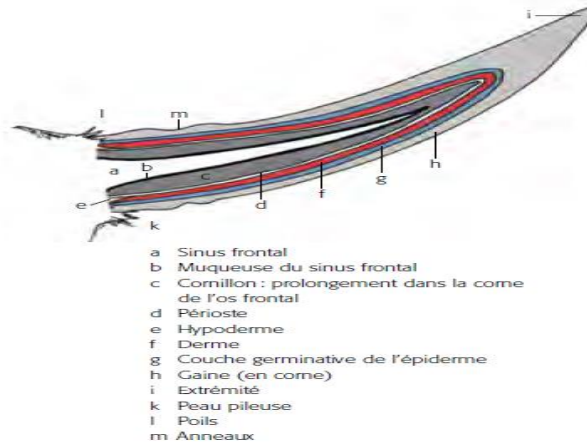


Figure 1-Longitudinal cuts of the Horn core

Although "dead", this fabric is produced by the alive one. It is composed of proteins rich in Sulphur, making fibers. It is present at the surface of the skin in the form of scales. Formerly, it was a material of value, ideal to manufacture several articles. In mythology, this matter of abundance symbolizes perpetual prodigality, it produces much from little [4-5].

After its development out of powder or Horn core, this substance will be injected into a basic composite material and will be tested then to evaluate its contribution on the reinforcement of the thermomechanical characteristics searched on basic material after adding [5]. To work out this new material, a set of actions will be approached and can be classified in four phases "Figure-2".

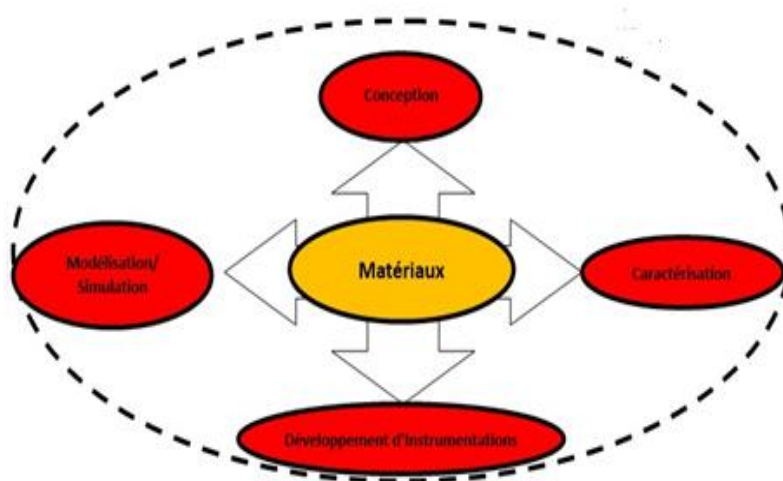


Figure 2-Methodology of studies of materials

2. CHARACTERIZATION OF THE VIRGIN MATERIAL EXPERIMENTALE STRATEGY

2.1 Development of the flanks

The transformation of the sheath into organic-load is obtained by the separation of this one of the Cornillon forming the selected substance. This material is very easy to work, once heated and softened, it is possible to split it, compress, saw, bore or turn. One can even weld part to make plates [4-6] of them. This stage makes it possible to obtain test-tubes for the mechanical tests by punching or cutting, particularly those of the tensile tests. It can be also transformed into ships and powders to be possibly used like loads in the plastics.

2.2 Process for the preparation of test pieces

Once heated and softened, the sheath is compressed during fifteen minutes in a press. This phase is followed by the process of milling for the completion of surfaces of the plate [7], according to the standard ISO 527-2 "Figure-3".



Figure 3-Sheath in the compressed State

Then, the plate is punched or cut out to give batches of test-tubes in conformity with the standard in force (Figure-(4 and 5)).

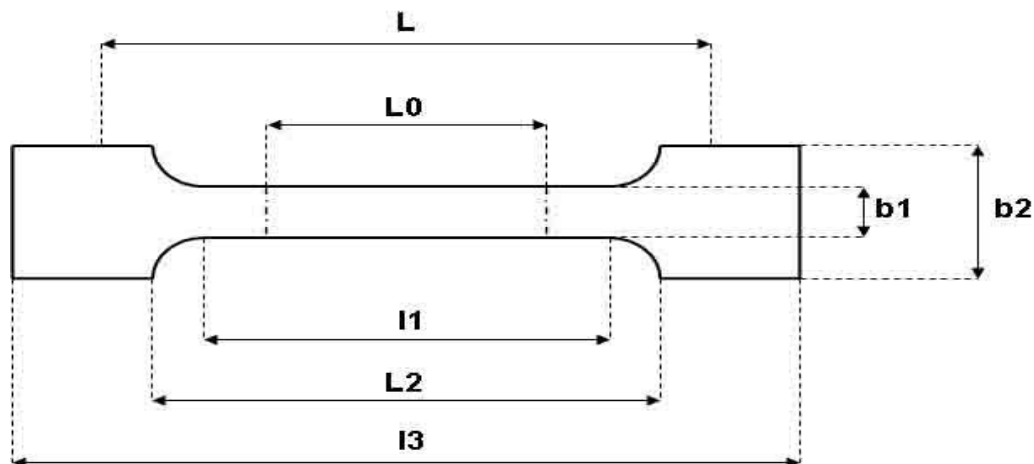


Figure 4-Drawing of specimen of standard traction



Figure 5-Lot of specimens of traction standard

The normalized values of the dimensions of the test piece which will be submitted to the tests are given in Table 1.

Table 1-Values normalized millimeters of the dimensions of the specimen to be tested

ISO 527-2	1BA	I3>75	$I_1=30^{\pm 0,5}$	$b_2=10^{\pm 0,5}$
Haltère	$b_1=5^{\pm 0,5}$	$h > 2$	$L_0=25^{\pm 0,5}$	$L_2=58^{\pm 2}$

The first objective of our experimentation is to check the advanced assumptions and to acquire criteria of positive classification and exploit in mechanical characteristics such as the maximum constraint with the rupture, the relative deformation and the Young modulus of virgin material. For this purpose, the side is cut out by chance out of test-tubes according to the standards ISO 527-2, standard 1BA and of form "Haltère" (Table 1) and a series of tests of traction is carried out on these test-tubes to test the elasticity of virgin material.

2.3 Machine used

For the tensile test, a universal tension and compression tester of type LLOYD Instruments LR50K is put in work at a speed crosses 1mm/min, a temperature of test of 23°C and a moisture of 50±10%. The test bench is equipped with auto-tightening bit and a cell of force having a capacity of 5kN. Its piloting is made by the software expert Test which at the same time makes it possible to consign the test parameters, gather and treat data "Figure-6".



Figure 6: LLOYD Instruments LR50K

3. ANALYSIS OF THE ELASTIC BEHAVIOR

3.1 The traction tests results

The tensile tests carried out on test-tubes containing material organic-charged gave rise to the result in the form of curves summarized in Figure-7:

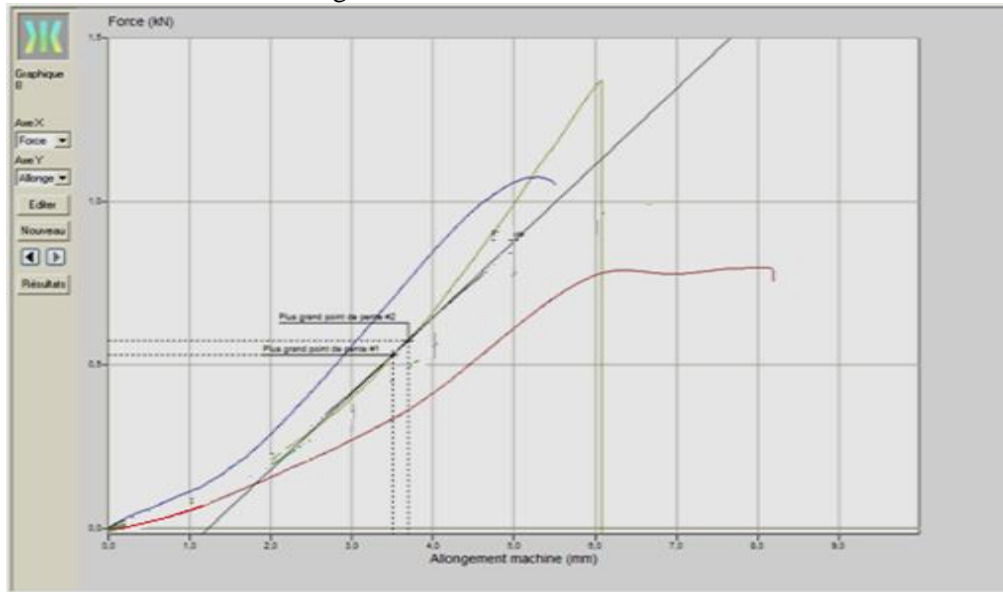


Figure 7-Traction curves

Table 2- Recorder Reading of the test traction

Group of test pieces	Stress at break (MPa)	% Elongation at break	Young's Module (MPa)
1	84,8	13,6	967
2	92,6	12,1	1296
3	61,5	16,4	829
Average	79,6	14,03	1030,66
Standard deviation	0,05	0,09	0,08

3.2 Analysis of elastic behavior

- A description of an intrinsic elastic behavior for each direction of cutting of the test-tube.
- A variability of reactivity of material to the requests with traction under similar conditions of experiment during the illustrating tensile test of the elastic behaviors different from the biomaterials (Table 2).
- An elastic behavior, characterized by the reversibility of the deformations during the suppression of the constraints, only appears for constraints lower than a limiting value, noted “Re”, which is called limit elastic, as the figure indicates it above. Nevertheless, beyond this limiting value, the permanent deformations are added to the elastic strain and/or well the rupture occurs. During the tensile tests on fibers, the ultimate constraint presents a relatively important dispersion as that is illustrated in the results part. That comes owing to the fact that the rupture is related to the preexistent fiber orientation. We can observe the typology of following behaviors:
 - Linear elastic behavior and irreversible plastic deformation. The biomaterials undergo a plastic deformation before breaking. It is a hard and tough material “Figure-6”.
 - Elastic, linear and reversible behavior. The rupture biomaterials occur whereas it is in purely elastic mode of deformation. It is a rigid and fragile material “Figure-6”.
 - Linear elastic behavior followed by an irreversible plastic deformation. The biomaterials undergo a permanent plastic deformation (important lengthening and constriction) before breaking. It is a less resistant and ductile material “Figure-6”.

We can notice, through the various results recorded of the elastic behaviors, as the biomaterials have interesting Young moduli being able to play a significant role in the improvement of the performances after the organic-loading of the composites.

5. CONCLUSION

The development of more respectful materials of the environment became a major concern for the industrial world and that answers an increasing a social request. Currently, the research orientations on these materials relate to the biodegradable materials organic-sources, materials and recycled materials. In this intention, we could contribute to the elastic characterization of a virgin material of animal origin by cutting out test-tubes by chance, then by testing its tensile strength on a tensile-test bench under similar conditions of experiment. It is noted that in these tests, the material underwent several tests of extension and one retained the experimental values most significant. The reactivity of the biomaterials to the requests of traction generated a variability of intrinsic elastic behaviors, knowing that three recorded behaviors are likely to be imposed through their evaluated characteristics: Maximum strength breaking, relative displacement and the Young module. The required objective was the valorization of the virgin biomaterials after its mechanical characterization.

This study showed that variation of mechanical qualities of the biomaterials respond to the direction of fibers of material: Different behavior in all the directions. It is a material with anisotropic behavior. This behavior is considered to be favorable to a development of the organic-load of animal origin for the innovation of certain composite materials. In terms of sustainable development, two principal approaches will be developed in this research future outlook: The development of the recycling of the animal bodies at the end of the lifetime thanks to the improvement of the performances of identification and the development of materials organic-charged with renewable resources starting from organic biomasses.

SCIENTIFIC OBSTACLES

The development of materials organic-sources and organic degradable requires the development of specific tests of evaluation of the biological breakdown of formulated materials. The end-of-life by composting must be maintained whatever the physical properties of materials and the surface treatments carried out. The development of materials from resources first and secondary requires obtaining increasingly important purity in order to aim at applications to strong added values.

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