COMAT

The 9th International Conference on Advanced Composite Materials Engineering

Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

17-18October 2022

CHARACTERISTICS OF TESTING METHODS OF BIOCOMPOSITES

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Abstract: *In general, for evaluating synthetic biocomposites from a physical, mechanical, chemical, thermal and electric point of view, are used methods and test procedures met in the case composite materials. In addition to this, there are also specific tests aiming at the biological in vitro and in vivo behavior of the biocomposite. The testing methods and procedures are regulated, in general, by standards and norms specific for the testing objective. In the paper are presented the methods for evaluating synthetic polymeric biocomposites without evaluating the biological in vitro and in vivo behavior of the biocomposite.*

Keywords: *biocomposite, biomaterials, tests, standards.*

INTRODUCTION

Biocomposites are found under several representations such as natural biocomposite with the representative shape of bone tissue, synthetic biocomposites that have both the matrix and the reinforcement from different types of synthetic biomaterials such as biometals, biopolymer and bioceramics [1] and biocomposites that have the fiber reinforcement natural,

mainly characterized by mechanical properties, specific to each type of fiber [2], also called ecological biocomposites.
As a whole, biocomposites are classified according to the types of the reinforcement used such as particle, fiber , structural and hybrid.
At the moment, there is no assessment of the share of use, in medical applications, of the three types of biocomposites, but it can be stated that in the case of synthetic biocomposites, the share is held by epoxy biocomposites reinforced with carbon and/or glass fibers and, more recently, by PLA/HA biocomposites.
Depending on the type of the medical application, specific tests are used to evaluate the limit performance of the biocomposite material in terms of physical, mechanical, chemical, etc. The tests can be destructive or non-destructive, the latter following the structural integrity of the biocomposite material during the development.

1. TECHNICAL REQUIREMENTS

Traceski [3] systemically presents the physical, mechanical, chemical, thermal and electrical tests typical for evaluating the performances of the polymeric composite materials, retrieved in table 1.

Table 1. Typical polymer composite material qualification tests, from [3]

Physical	Mechanical	Chemical
Resin content	Tensile strength and modulus	Infrared spectroscopy (IR)
Resin areal weight	Compression strength and	Liquid chromatography (HPLC)
Resin flow	Short beam shear (SBS)	Hydraulic fluid/solvent
Glass transition temperature	± 45 In-plane shears	Fuel (JP-4) resistance
	Open-hole voltage	resistance
Rheological dynamics spectroscopy (RDS)	Open-hole compression	**Thermal**
	Compression after impact (HORSE)	Thermogravimetric analysis (TGA)
Gel time		
Volatile content	Flexural strength and modulus	Thermomechanical analysis (TMA)
Fiber density	Fatigue strength	
Fiber mass per unit length	Creep	Differential scanning calorimetry (DSC)
Fiber content	Dynamic mechanical analysis (DMA)	
prepreg tack		Thermal oxidative resistance
Laminate ply thickness	Instrumented impact (Toughened resins)	Thermal expansion (CTE)
Laminate void content		Thermal cycling
Laminate density	Fracture toughness (toughened reviewed)	Thermal conductivity
Fiber volume laminates		**Electricity**
Laminate flammability	Solvent sensitivity compression strength, SBS	Dielectric constant
		Dielectric strength
	Bolt bearing	Dissipation factor
		Volume resistivity
		Dielectrometry

When manufacturing and evaluating synthetic biocomposites, the mechanical (Tab.2) and thermal tests are being used a lot more often, especially [4], [5], [6], [7] the tensile test, the flexure test, the compression test, ± 45 ,in plane shear (Fig.1), dynamic mechanical analysis (DMA), differential scanning calorimetry (DSC) and thermal expansion (CTE).
The preparing and taking place of biocomposite tests are regulated by ISO, EN, ASTM standards (Tab.2) etc.

In the case of the synthetic biocomposites tests are also used tests regarding the biological in vitro and in vivo behavior of the synthetic polymeric biocomposite, mainly taking into consideration the biocompatibility properties [8].

Table 2: Mechanical tests for polymer matrix / fiber-reinforced plastics (bio)composites, from [5], [6], [7]

Test	Standard
Tensile test	ISO 527-1 [*ISO.527-1], ISO 527-2, ISO 527-3, ISO 527-4, ISO 527-5, ASTM D638 [*D638], ASTM D3039 [*D3039], EN 2561 [* EN2561], EN 2597 [*EN2597]
Compression	ISO 14126, ASTM D695, ASTM D3410, ASTM D6641, ASTM D5467, EN 2850
flexure	ISO 14125, ASTM D790 [*D790], ASTM D6272, ASTM D7264, EN 2562, EN 2746
In plane shear	ISO 14129, ISO 15310, ASTM D3518, ASTM D4255, ASTM D5379, ASTM D7078, EN 6031
Shear	ISO 14130, ASTM D2344, EN 2377, EN 2563, EN 2563, JIS K 7078, DIN 65148, ASTM D 4475
Fracture toughness, Mode I and II, mixed mode	ISO 15024, ISO 15114, ASTM D5528, ASTM D6115, ASTM D6671, ASTM D7905, EN 6033, EN 6034

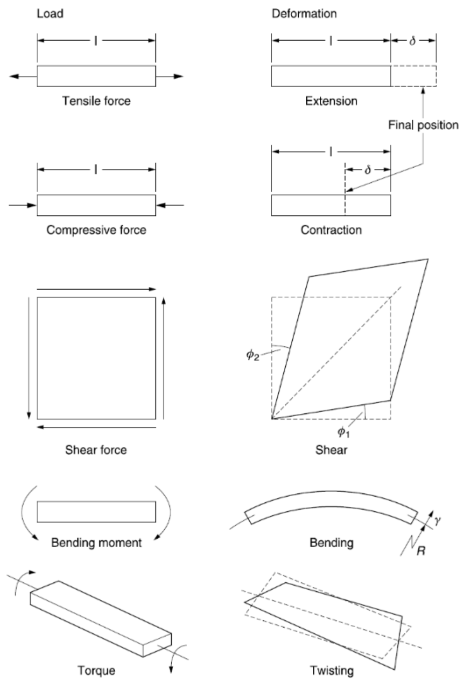

Figure 1: Types of mechanical tests for composite materials: t he loads with associated deformations of composite materials, from [4]

2. CONCLUSIONS

The methods and procedures for testing synthetic biocomposites are retrieved, in general, from those used for biocomposite materials. The tests are regulated, in general, by standards and norms specific to the objective of the test. To these are added tests regarding the in vitro and in vivo behavior of the synthetic polymeric biocomposite.

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