THE INFLUENCE OF MISCHANTUS FIBER INSERTION ON THE MECHANICAL PROPERTIES OF COMPOSITE MATERIALS BASED ON STARCH OBTAINED BY THERMOFORMING

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Keywords: starch, biopolymer, Mischantus

ABSTRACT

The thermoplastic starch (TPS) can be used in some applications which do not require high mechanical performance. In order to fulfill their potential utilization as synthetic alternative, the mechanical properties of TPS must be enhanced This paper present the influence of fiber insertion on a composite material based on native thermoplastic starch to improve the theirs mechanical properties.

INTRODUCTION

Increased volume of plastic wastes, the high expenses for their recovery and limiting the available places for their disposal, lead to necessity of development of biodegradable materials which can replace the non-degradable plastics. Biopolymers are polymers of renewable materials and are biodegradable at the end of life. For now, there are biodegradable polymers available on the market, like polylactic acid (PLA) and polycaprolactone (PCL), but their massive use as substitutes of traditional polymers is restricted by their comparatively high cost [1].

In the search of economically attractive biopolymers stands the thermoplastic materials obtained by plasticization of starch, because its widespread and renewable nature.[Raquez JM, Nabar Y et all, New developments in biodegradable starch-based nanocomposites.Int Polym proces2007;22(5):463-70].

The thermoplastic starch (TPS) can be used in some applications which do not require high mechanical performance. In order to fulfill their potential utilization as synthetic alternative, the mechanical properties of TPS must be enhanced [2].

DIN CERTCO (2001) state that lignocellulosic fibres can be incorporated in the biopolimer to a level of 49% without affecting the compostability of products certified to the DIN 54900 norm. [3].

Lignocellulosic fibres are any substance that contains both lignin and cellulose (wood, agricultural crops,grasess etc.). Due to its content of lignin and cellulose, Miscanthus can be classified as a lignocellulosic fiber.

In this paper we present the result of mechanical tests (tensile stress and tensile strain) on a new TPS formula reinforced with Mischantus fibers

MATERIAL AND METHOD

Thermoplastic starch (TPS) was prepared from industrial non-modified corn starch, with a 21% content of amylose. The initial water content of starch on wet basis (wt.b) was 10.76% and the density was 0.561 g/cm^3.

The glycerol used in formula was purchased from SC Nordic Invest SRL Cluj Napoca and has had a concentration of 99.5% and a density of 1.262 g/cm^3.The water used was from the water supply system. The ratio of starch/ glycerol/ water was 55/28/17.

To achieve the desired mechanical resistance under tensile stress without affecting other properties, reinforcement with fibers was necessary.

Fiber strands from mischantus were used as reinforcement at different proportions ranging 5%, 8% and 10% referred to the starch/ glycerol/ water matrix.

The samples were prepared by pre-mixed the starch with the fibers, than we add the glycerol and water and we mixed it manually. The resulting blend was thermo-pressed, at 190 ^oC for 20 min, in order to obtain the mechanical assay specimens. Tensile tests were perform to determine the tensile stress and tensile strain, on a Instron 3360 Series Dual Column Tabletop Universal Testing Systems.

For each material were tested 5 specimens.

RESULTS AND DISCUSSIONS

Thermoplastic starch (TPS) used in formulas, has been obtained from native corn starch, glycerol and water. Composite materials obtained thorough reinforcement of the thermoplastic starch matrix with mischantus fibers have been thermo-pressed to obtain the samples : 10 mm width and 3.5 mm thickness

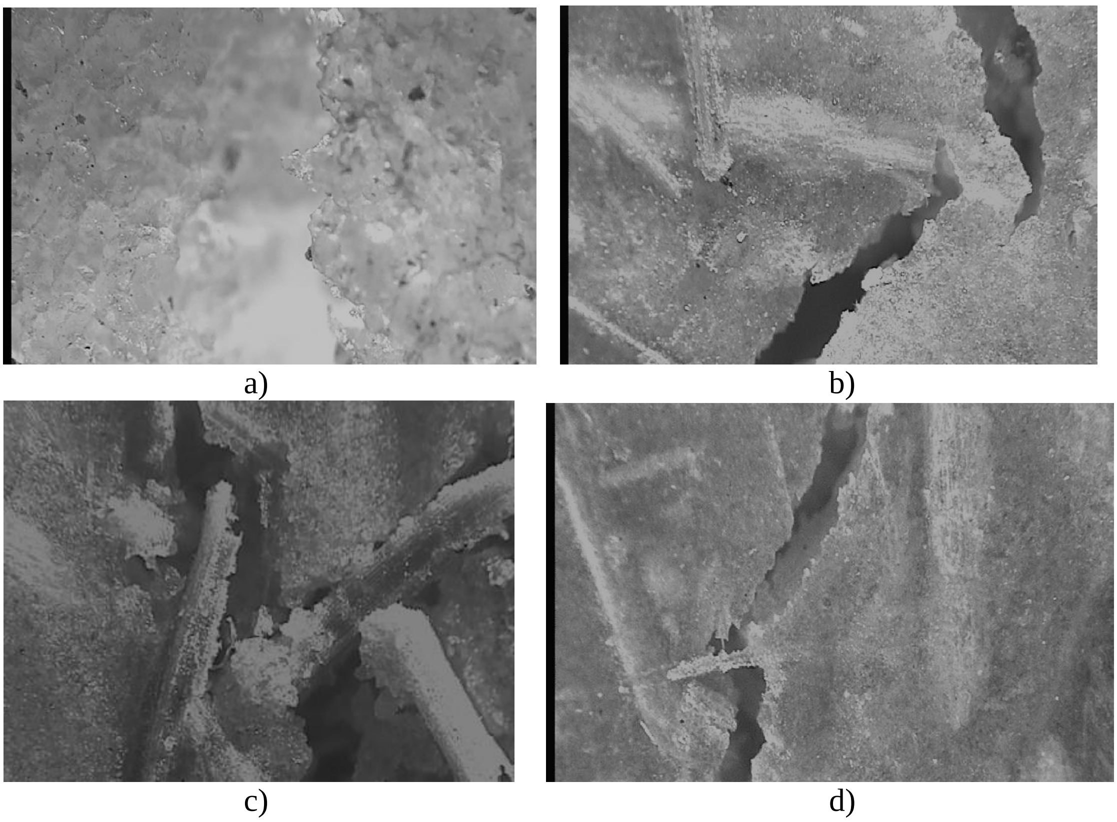
The ratio of the components in the samples are shown in Table 1.

Table 1

Components ratio in the composite materials

Material	Starch [gr]	Glycerol [gr]	Water [gr]	Fiber content [gr]
S0	50	25	15	-
S1	50	25	15	5
S2	50	25	15	7.5
S3	50	25	15	10

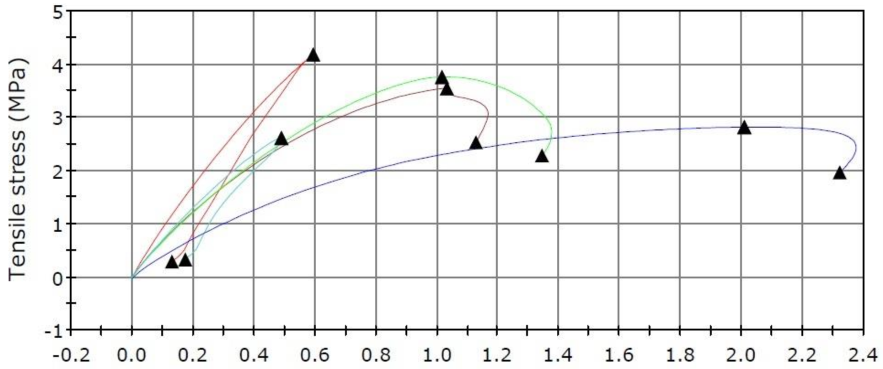
For many applications the mechanical properties of the starch based materials is the weak point. Reinforcement with fibers was necessary to improve the mechanical resistance under tensile stress without affecting other properties of the composite.



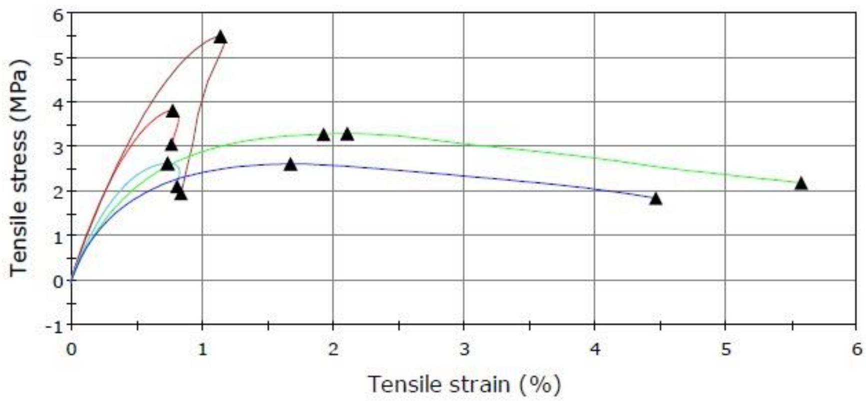
a) b) c) d)

Fig. 1 *– Microphotographs of external fracture of samples: a-S0, b-S1, c-S2, d-S3*

The images of external rupture of samples (fig.1 b,c,d) showed the miscanthus fiber dispersion within the material –the fibers appear individually, and show that the composite had poor interfacial bonding (the fiber surfaces are well contoured and clean) fact that determine the increasing of fracture toughnes . Microphotographs also show the effect of the fracture on the fibers- during the fracture process the fiber seem to be pulled out.



a)



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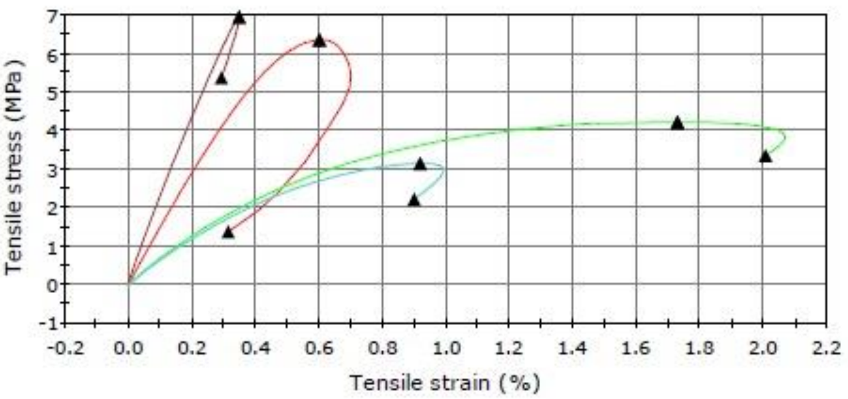

c)

***Fig. 2** – Variation of tensile strain vith the tensile stress for samples: a-S1, b-S2, c-S3*

Regarding the tensile properties , as it can be seen from data Tabel 2 and Fig.2, addition of miscanthus fibers caused an improvement on tensile stress. Instead increases the fiber content determined the tensile strain decreases. As expectet the reinforcement with miscanthus fiber caused a decrease in the flexibility of the material, as is shown in Tabel 2 (the sample with 10 g of fiber has the lowest tensile strain at break: 0.88 Mpa for S3 comparing with 3.71 MPa for material whithout fiber).

Table 2

Efect of miscanthus fibers on tensile properties of the composite material

Sample	Tensile stress at maximum load [MPa]	Tensile strain at maximum load [MPa]	Tensile stress at break [MPa]	Tensile strain at break [MPa]
S0	**0.36**	**2.91**	**0.33**	**3.71**
S1	**3.38**	**1.03**	**1.48**	**1.02**
S2	**3.57**	**1.29**	**2.12**	**0.84**
S3	**5.17**	**0.9**	**3.09**	**0.88**

Large variations in the behavior of samples at tensile stress (fig.2) is caused by the formation of samples following that for achieving conclusive results to form the samples by other means.

CONCLUSIONS

The results of the tensile stress indicate that incorporating Misghantus fibers into thermoplastic native starch improve the tensile stress resistance but decrease the flexibility of the material. The technology to produce the samples seem to influence the behavior at tensile stress so it will be intresting to compare the resistance at tensile stress and the tensile strain on samples obtained by diferent technologies.

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