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POLYOLEFINE COMPOSITES REINFORCED WITH CURAUÁ FIBERS PREPARED BY EXTRUSION: EFFECT OF SCREW ROTATION

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Abstract – Composites of polypropylene, PP, and high density polyethylene, HDPE, with curauá s were prepared using an intermeshing co-rotating twin screw extruder at different screw rotations. The effects of the screw rotation on the geometry of the Curauá fibers extracted from the composites and on the mechanical properties of injection molded samples were evaluated.

During processing of natural fiber/polyolefin composites by extrusion, the effect of screw rotation must be analyzed in relation to productivity and final mechanical properties of the injection molded composites. The final aspect ratio, AR, of the fiber reinforcement is an important parameter related to the mechanical properties of composites and is affected by the processing conditions. The efficiency of the reinforcement increases with fiber AR, reaching a plateau.[1] Processing conditions may also induce thermo-mechanical degradation of the polyolefin.[2] Curauá fibers, supplied by Embrapa-PA (Brazil), were milled in a three knives rotary mill to 3-7 mm length (AR=50 to 115). Composites with 20 wt% of fibers, PP or HDPE, were processed in a ZSK 26 Mc, Coperion extruder, L/D=44 and temperature profile, from feed to die, 160-180 ºC for PP and 120-140 ºC for HDPE. Screw rotations, SR, used were: 250, 300, 350, 400 and 500 rpm. Fibers were fed through a side-feeder. The granulated composites were dried at 100 ºC for 1 h and injection molded (Arburg, All-rounder M250) into test specimens for tensile and flexural tests. Tensile and flexural tests were done according to ASTM standards. Fibers were isolated from the matrices by extraction in boiling xylene for 1 h and dried at 100 ºC. An optical microscope connected to a digital camera was used to collect the fiber images and the Image Pro Plus® software was used to determine the dimensions of the fibers. Fiber AR ratio decreases with increase in screw rotation for both polyolefin matrices used; above 250 rpm for HDPE and 300 rpm for PP, Table 1. This is caused by the shear increase and affects the mechanical properties of the composites. The yield stress and Young's modulus for the composites show a decreasing tendency in the range of SR studied, Table 1. This is in accordance with fiber AR, which decreases for processing at higher SR. The elongation at break presents opposite behavior due to the decline in the reinforcement effect. During extrusion the matrix also suffers thermo-mechanical degradation induced by shear and heat.[2] Thus, the loss in mechanical properties at higher SR may have a contribution from the thermo-mechanical degradation of the matrices.

Table 1: Effect of SR on: fiber aspect ratio, AR, tensile yield stress (σ_{max}), Young's modulus (E) and elongation at break (ε), composites flow and processing temperature, P. temp., measured in the extruder barrel.

HDPE matrix						
SR/rpm	AR	σ_{max}/MPa	E/MPa	ε /%	Flow/kg.h^{-1}	P. temp./ ºC
250	18	28.5	2.4	1.4	1.9	136-160
300	16	27.8	2.3	1.3	2.2	143-164
350	15	26.6	2.2	1.6	2.4	140-168
400	12	25.7	2.0	1.9	3.1	151-172
500	7	24.5	1.9	2.1	3.5	145-178
PP matrix						
250	15	31.3	3.4	3.9	2.5	171-195
300	15	30.4	3.4	4.2	2.6	177-195
350	13	29.7	3.2	4.7	2.6	177-199
400	11	28.8	3.2	4.4	2.9	175-204
500	9	27.1	3.3	5.1	3.6	178-202

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