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Influence of Processing on the Mechanical Performance of Textile Waste

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Introduction

In contemporary societies characterized by advanced technologies and unprecedented material availability, individuals have increasingly turned their attention to environmental sustainability. Synthetic fibers were first introduced in the late 1930s, their usage has grown rapidly and now about 70% of the fibers used globally are synthetic fibers such as polyester, nylon, etc. Unlike natural fibers that originate from plant and animal sources, synthetic fibers are typically not biodegradable [1-3].

Objectives

This study focuses specifically on processing conditions, with particular emphasis on how cooling parameters – namely, time and temperature – govern the microstructural development of the recycled material and, consequently, its mechanical and dynamic performance.

Metodologia

Textile waste was collected from small manufacturers in Nova Friburgo, Rio de Janeiro, a region recognized for its extensive textile production. The material was dried in two stages and processed using an AX Plásticos single-screw extruder, model AX 30:32, operating under isothermal conditions at 200 °C for all five processing zones, with a screw speed set at 70 rpm. After extrusion, the material was cooled and granulated. Approximately 50 g of the granulate were then pressed with a 3 mm metal spacer using a Carver press (model 3851-0C) at 240 °C, 10 psi of pressure, for 15 minutes, and four distinct cooling methods were employed:

1. Circulating water until the plate temperature reached 70 °C; 2. Circulating water until the plate temperature reached 50 °C; 3. After the pressing period, an immediate thermal shock was applied in a water bath maintained at 25 °C; 4. After the pressing period, with the pressure maintained, the mold was allowed to cool gradually to room temperature.

Results e Discussion

Figure 1 presents the strain–recovery curves of the textile waste subjected to the different processing conditions. Sample M3, quenched in a water bath, clearly exhibited the highest creep deformation during the loading period. Likewise, in the recovery stage, it showed the second-lowest elastic response, which is consistent with the lower crystallinity developed in the nylon 6/elastane blend. In contrast, sample M1, cooled to 70 °C, is likely the specimen that achieved the highest degree of crystallinity and/or the greatest crystalline perfection of the nylon 6 phase, as it not only displayed the lowest deformation but also reached the highest recovery rate. Samples M2 and M4 occupy intermediate positions between the extremes represented by M3 and M1. The slow air cooling at room temperature likely contributed to the development of crystalline regions in M4 that were more effective in restricting polymer chain slippage than those formed in M2, although this does not necessarily imply a higher overall crystallinity for M4.

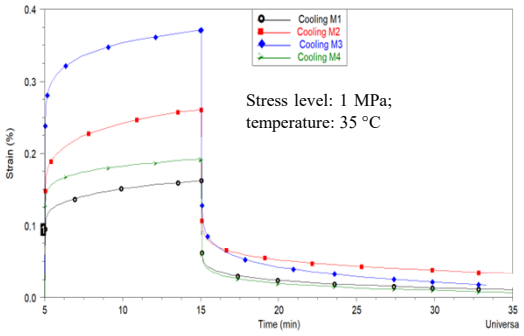


Figure 1. Influence of Processing Conditions on the Creep Behavior of Textile Waste

Conclusions

It was demonstrated depending on the processing parameters – most notably the cooling conditions – the resulting material may become stiffer and less prone to creep, or, alternatively, more compliant and characterized by reduced dimensional stability under constant load.

References e Acknowledgments

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