

**PROCESSING PARAMETERS/MICROSTRUCTURE/PROPERTIES
RELATIONSHIPS IN PA6/PA6/LDHs SYSTEMS: EFFECT OF MATRIX
VISCOSITY AND ELONGATIONAL FLOW**

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Abstract

In this study, the processing parameters-microstructure-properties relationships in melt blended polyamides 6 (PA6s)-based materials were studied, also considering the application of a uniaxial elongational flow. At the same time, the effect of a different viscosity and shear rate imposed during compounding was evaluated. Thus, the resulting microstructure, in terms of crystallinity and different crystalline phases, was investigated according to a three-parameters system of variables.

Firstly, the research focused on unfilled PA6-based systems. A high-viscosity (HV) and a low-viscosity (LV) PA6s were exploited, along with the blend containing 30 wt% of HV and 70 wt% of LV. The materials were compounded in a co-rotating twin-screw extruder and two different screw rotation speeds (namely, 150 and 300 rpm) were selected. Furtherly, through a RheoSpin apparatus, a uniaxial elongational flow was applied to the molten material coming out from the extruder.

From the comparison of the crystallinity content and polymorphism in the fibres with those in the extrudates was appreciated the positive impact of the elongational flow on the formation of the more stable α crystalline phase at the expenses of the γ one, according to what is reported in the literature for PA6-based systems.¹ On the other hand, the overall crystallinity content did not show a clear dependency from the application of the elongational flow. Besides, the role of the elongational flow in determining the microstructure was evaluated taking into consideration the different viscosities of the matrices and screw rotation speeds exploited during the processing.

Furthermore, the tensile properties of the fibres in terms of tensile strength and elongation at break were characterized, aiming at relating the mechanical performances with the microstructure and, as a consequence, with the processing parameters.

Lastly, two Mg-Al layered double hydroxides (LDHs) having different aspect ratio were introduced as nanofillers in the materials characterized above. Specifically, the two LDHs are characterized by a D_{50} of 8.39 μm and 18.67 μm , respectively. For both nanofillers, the content in the nanocomposites was maintained constant at 10 wt% and the compounding was performed in the twin screw extruder with the same processing parameters as the unfilled materials. The role of the LDH size was investigated as further parameter allowing to determine the microstructure and thus the final properties.

According with the literature,² the beneficial effect of the application of the elongational flow on improving the dispersion of the nanofiller was appreciated. Besides, despite the nanofiller size considered, higher values of the drawing speed at break were obtained during the application of the elongational flow for the nanocomposites as compared to the unfilled PA6-based materials.

In addition, the synergistic role of the processing parameters also emerged from the tensile characterization of the LDHs-containing fibres. In this case, the stiffness appeared to be promoted by the greater aspect ratio of the embedded nanofillers, but was also heavily affected by both the viscosity of the polymer and the screw rotation speed considered during the melt compounding step.

¹ R. Arrigo, N. Tz. Dintcheva, G. Nasillo, E. Caponetti. Polyamide/Carbonaceous particles nanocomposites fibers: morphology and performances. *Polymer Composites* 2015, 36, 1020-1028

² C. Gnoffo, R. Arrigo, M. Sisani, A. Frache. Elongational flow-induced microstructure evolutions in polypropylene/layered double hydroxides nanocomposites. *Polymer Composites* 2024, 45, 6606-6617