Properties enhancement in polymer composite materials, as controlled release, thermal, electric and magnetic behavior, using natural nanofillers with tubular shapes strongly depends on the nanotubes individual separation as well as their homogeneous distribution in the polymer matrix. The nanofillers degree of dispersion in a polymer matrix could be related to the adhesion and interfacial strength between them. A typical strategy in polymeric materials to overcome with the chemical compatibility between filler and the matrix could be the use of compatibilizer additives. The additives have to be evaluated in combination with melt processing variables in order to optimize the degree of dispersion. In this study, the morphology properties of the obtained materials were analyzed in order to generate a quantification method of the degree of the dispersion. The modelling case materials in this case were halloysite as filler, and polypropylene, as polymer matrix.

Quantification methods for the degree of dispersion of nanoparticles in polymer materials represent a challenge when the morphology properties have to be correlated with the physical properties of the materials. Until now there is no simple and exhaustive method to cover all kind of applications even more if the applications are related to industry. In this study an effort to overcome those difficulties is been proposed using image analysis and the definition and quantification of morphology parameters for polymer composites prepared by melt extrusion in two stages: masterbatch and nanocomposite using tubular nanofillers. The analysis is been done considering industry resources related with low time and equipment characterization of materials.

The methodology involved the realization of a Plackett-Burman experimental design. The imaging uptake considered several magnification and combination of detectors using Optical Microscopy, and Electron Microscopy (SEM&TEM). The main results considered the morphologies of the raw materials, regarding tubular nanofillers, as well as the masterbatch and the nanocomposites prepared by melt compounding. The quantification of the morphological properties was realized using statistical methods. The measured values include agglomerates quantification by size and number, dispersed area %, agglomerated area % and so on. The information was used to calculate parameters as deagglomeration and eccentricity factors. In addition, evidences for the adhesion and interfacial strength were obtained for each material.

In summary an efficient methodology for the quantification of the degree of dispersion of composites prepared in melt was developed. The main advantages for the industry are the low time and physical resources.

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Fig. 1: SEM original micrograph and treated image for the composite masterbatch of Run 6 of tubular nanofiller in polymer matrix. The images were obtained using a FEI-Phillips SEM XL-30 at 20 kV and 650x using BSE detector. The dark zone is associated with the polymer and the bright zone is associated with the agglomerates of tubular nanofillers.

Fig. 2: SEM original micrograph and treated image for the polymer composite of Run 9 of tubular nanofiller in polymer matrix. The images were obtained using a FEI-Phillips SEM XL-30 at 20 kV and 650x using BSE detector. The dark zone is associated with the polymer and the bright zone is associated with the agglomerates of tubular nanofillers.