Mechanical and thermal properties of recycled mixed waste polymers reinforced with reclaimed newsprint fibres

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In recent years the extensive production of fossil-based plastics poses a great threat to the possibilities of maintaining the quality of the environment and diminishing the non-renewable petrol sources. Global demand for petrochemical feedstock in plastic processing industry accounted for 12 million barrels per day (bpd), or roughly 12 percent of total demand for oil in 2017. The figure is forecast to grow to almost 18 million bpd in 2050. To this end, several methods were developed to decrease our reliance on raw fossil-based materials (Qualman, 2017).

To maintain the quality of our daily lives and to limit the use of non-renewable sources, i.e. fossil fuel, the search of the alternative materials that are aligned with the environmental strategies on resource efficiency, stipulated by the EU directives, have been stimulated greatly in recent years. Reasons for this green shift transition can be found in the growing ecological, social and economic awareness and evermore restricted law regulations (European Bioplastics, 2018; Shen, Haufe and Patel, 2017). The world-wide availability of natural fibres, abundant access of agro-wastes, relative cheapness of these natural resources, and their ability to be recycled are the catalysators for the ever-increasing interest in research of these new sustainable concepts (Jacob John and Thomas, 2008). Besides the listed motivations, natural fibres have found several applications because of their desired characteristics, i.e. lower density, less abrasive processing conditions and its reinforcing potential to impart the mechanical properties of the resulted thermoplastic composites. The idea of using natural fibres as a reinforcement in composite materials is not a new or recent one. It has been a part of man's technology since the first ancient builder used straw to reinforce mud bricks. However, finding some alternative sources of natural fibres from post-consumer waste and how they will be processed with the recycled solid waste plastic for the mass production of new products is a new concept, driven by the circular economy business model.

This study presents the mechanical and thermal properties of environmentally friendly composites made of reclaimed newsprint paper fibres and recycled polyethylene mixtures (HDPE and HD/LD PE) obtained from post-consumer wastes, with the addition of highly maleic anhydride grafted polyethylene wax (MA-PE) and semi crystalline copolymer of propylene and ethylene (VISTAMAXX™), as compatibilizer and impact modifiers, respectively. The effect of high filler content addition (40 wt.% of newsprint fibres) on the mechanical and thermal properties of recycled HDPE and HD/LD PE blends were investigated by twin-screw extrusion and injection moulding process. The fibre addition resulted in higher modulus of elasticity for both, the HDPE-based matrix (for 24% higher E_t compared to plain HDPE) and the HD/LD PE-based blend (up to 86% higher E_t compared to plain matrix). However, the tensile strength of the composites varied dependently of the selected matrix. In HD/LD PE the addition of newsprint paper gave a rise of the composite stiffness for up to 63%, while the inclusion of fibres in HDPE resulted in 32% lower strength compared to the plain matrix. Scanning electron microscope (SEM) photomicrographs of the impact fracture surfaces demonstrate a solid adhesion bond for all the investigated materials.

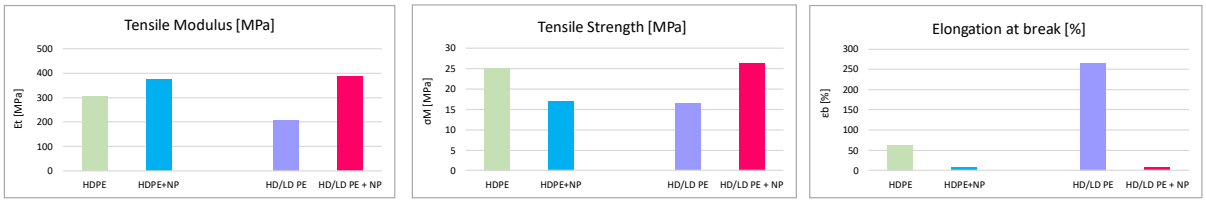

Figure 1. Mechanical properties of newsprint fibre reinforced composites with respect to the type of recycled polyolefin matrix

Differential scanning calorimetry (DSC) showed that the presence of newsprint fibres affects the polymer crystallization kinetics through a more orderly arrangement of crystallites, which in turn leads to an improved melting resistance of the resulted composites.

The level of mechanical properties achieved the prosperous potential of green based composites for the use in several types of industrial applications. Recycled PE blends of HD/LD mixed with newspaper fiber appears to be a good alternative in the manufacture of environmentally friendly products.

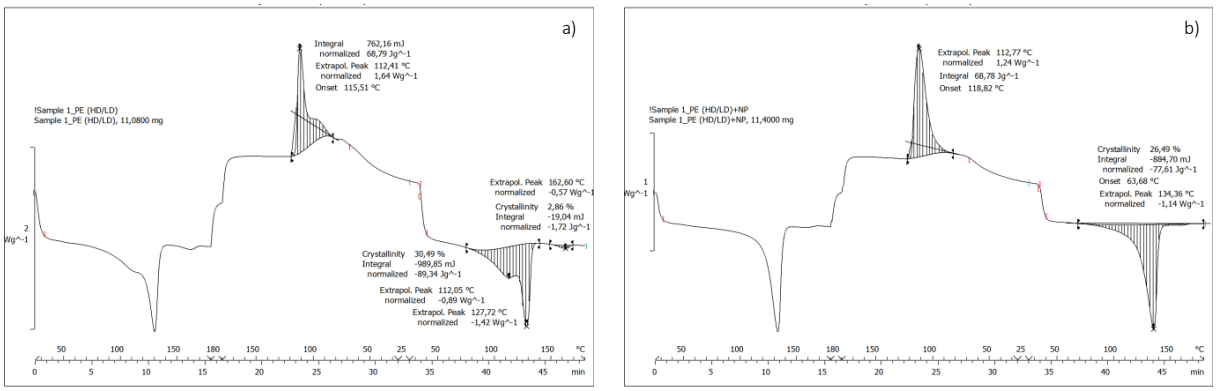

Figure 2. DSC results of a) plain HD/LD PE, and b) HD/LD PE reinforced with 40% of newsprint fibres

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