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Technical Note

Continuous Micro-Compounding of Short Carbon Fibre Reinforced PBT Using an Xplore MC 40 & Pro-Pelletizer

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Short carbon fibre (SCF) reinforced PBT can be used in electrical and electronics sector to make strong, light and electrically conductive parts such as electrical devices and displays, electrical components and infrastructures. Due to the anti-static character of this compound, dust or dirt adherence is relatively lower to the component that allows it to work reliably and permanently under harsh conditions without damages caused by electrostatic discharge.

In this preliminary work, we demonstrated the continuous micro-compounding of PBT/SCF in an Xplore MC 40 conical twin screw (co-rotating) extruder in combination with continuous pelletizing using an Xplore Pro-pelletizer.

A general-purpose PBT was compounded with polyester compatible commercially available short carbon fibers. The micro compounding line was consist of an MC 40, Xplore's 40 mL micro-compounder, equipped with two feeders containing PBT pellets and SCF (See Fig 1).
A calibration of these volumetric feeders was carried out to achieve 15% SCF in PBT matrix. The screw speed of MC 40 was set to 100 rpm, and the barrel temperature was st at 240°C. The extrudate coming out of MC 40 was chilled in a water-bath and then pelletized using an Xplore pro-pelletizer. A video of the continuous microcomputing process can be viewed here:
https://www.youtube.com/watch?v=EGxqdLjxStQ

(a) (b)

Figure 1. The continuous micro-compounding line with an MC 40, water bath and an Xplore Pro-Pelletizer.

One of the important parameters that controls the performance of a short fibre reinforced composites is the distribution of the short fibers within the matrix. In this work, scanning electron microscopy (SEM) was utilized to examine the distribution state of the carbon fibres in PBT matrix. It was monitored that the SCFs were homogenously distributed within PBT (Figure 2). In addition, a good orientation of SCFs was observed.

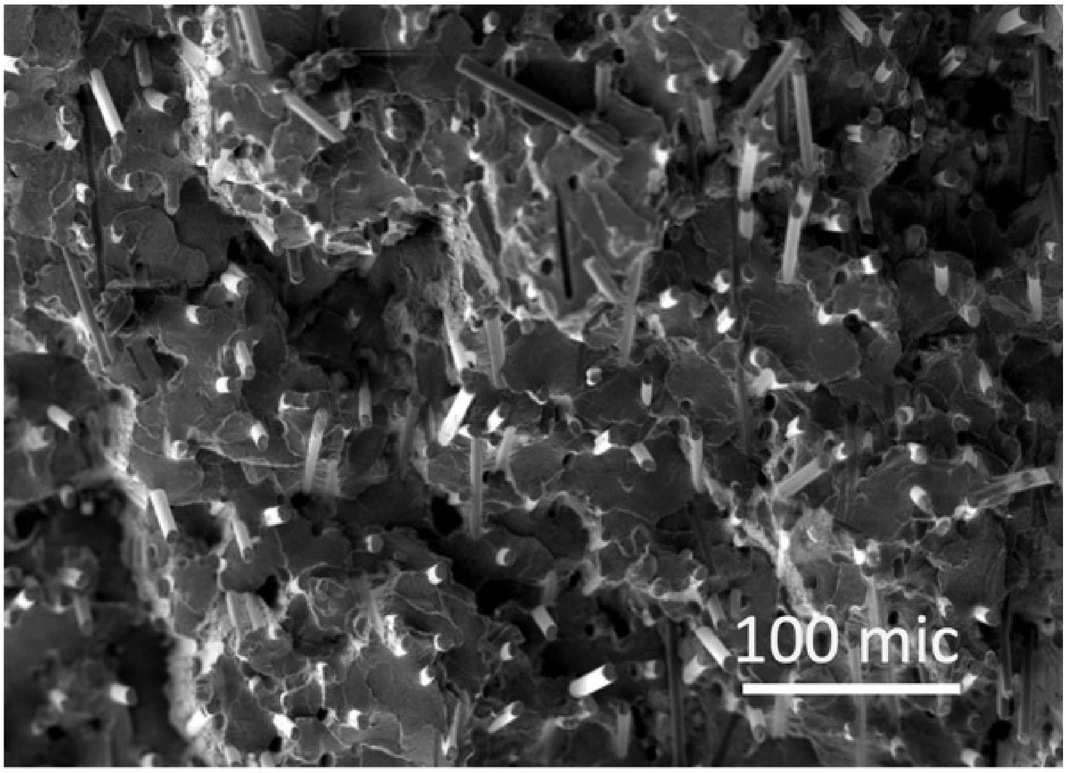

Figure 2. SEM micrographs of the fracture surface of PBT/SCF composites

The average fibre length in short fiber reinforced composites is the other important parameter, since the fibres that are shorter than the critical fiber length cannot bear load and hence will be pulled out under tensile loading. In order to measure the fiber length, the residue of burned composite was analyzed under light microscope (see Figure 3). It was found that the average fiber length is 400 ± 165 μmeter, which is in correlation with the data represented in the literature for other SCF reinforced thermoplastics.

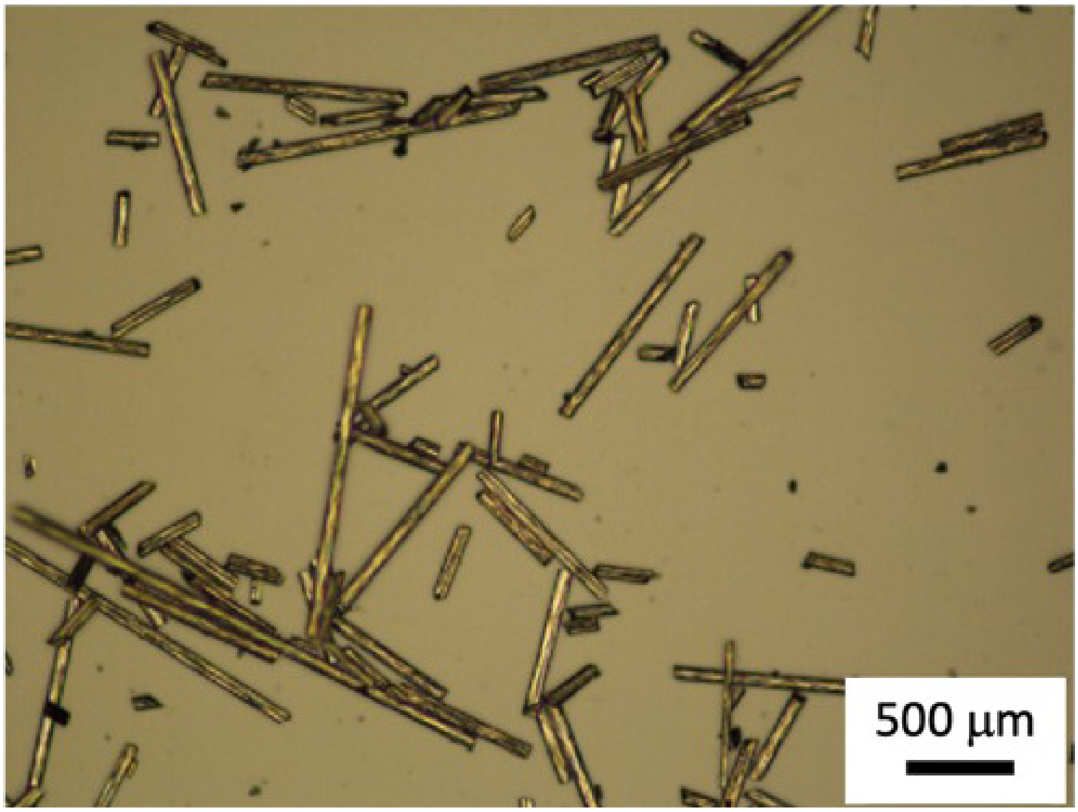

Figure 3. Light microscope image of residual SCFs after burning the matrix

The mechanical performance of PBT/SCF composites were summarized in Table 1. An Xplore IM12 injection molding machine was used to obtain the tensile and flexural bars. It is seen that the incorporation of 15% SCF into PBT matrix improved the tensile and flexural properties. The mechanical properties presented here are in line with commercial technical data sheets of PBT/15% SCF composites. One of the benefits of having well dispersed carbon fibers in PBT is the high electrical conductivity due to the conductive nature of CFs. The surface resistivity of PBT/15% SCF composites were found around 5×10^2 - 5×10^3 ohms, indicating a conducting surface that can allow surface discharge.

Table 1: Tensile properties of PBT/SCF composites

Sample name	Tensile Strength (MPa)	Tensile Strain at Yield (%)	Tensile Modulus (GPa)
PBT	57.0	4.0	2.6
PBT 15CF	123.6	2.8	11.1

Sample name	Flexural Strength (MPa)	Flexural Strain at max. load (%)	Flexural Modulus (GPa)
PBT 15CF	144.4	3.2	13.2

As a summary, this work demonstrates the versatility of an Xplore MC40. In combination with an Xplore Pro-Pelletizer, an MC40 can serve as a highly effective continuous micro-scale compounder to prepare various polymer compounds, such as polymer blends, composites, nanocomposites, etc. to accelerate R&D for novel polymeric materials.

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