Electronic Supplementary Material (ESI) for RSC Advances.

Material and methods

1 Material

The three OBCs are commercial products by Dow Chemical Company. PP1, PP2 and PP2 are commercial product produced by Dushanzi Petrol. Chem., Taiwan Formosa Plastics Corporation and Baota Petrochemical Group, China, respectively.

The detailed properties are included in Table1-2.

Table 1 Characteristics of the OBC materials.

Sample code	Brand	Octene content(%)	Soft segment(%)	Hard segment(%)	Crystallinity (%)	Tm(℃)
OBC1	9530	10.4	65	35	24	123
OBC2	9500	12.9	75	25	17.8	122
OBC3	9507	15.3	88	12	10.7	123

Table 2 Characteristics of the PP materials.

Sample code	Brand	Density g/cm^3	MI g/10min	Crystallinity (%)	Tm(℃)
PP1	1005	0.91	0.5	35.5	165.4
PP2	T30S	0.90	3	38.6	164.4
PP3	225	0.90	20	36.2	163.3

2 Methods

2.1 Flow behavior of neat OBC and iPP

In order to detect the rheological properties of raw material, the apparent viscosity was measured by Advanced Capillary Rheometer (RH7, Germany). The diameter of the capillary die was 1 mm, and its L/D ratio was 30:1. The testing temperature was carried out at 190 °C. The shear rates were over a range from 10 to 2000 s^{-1}.

2.2 Preparation of composites

The in situ PP/OBC nano-fibrillar blends were fabricated through a single-screw extruder equipped with a convergent die. The temperature profile from hopper to die of the extruder was 110, 190, 190 and 185 °C. The extrudate was hot stretched by a take-up device with two pinching rolls immediately after extruded from the die. Stretching ratio of 16 (i.e., the area of cross section of the die to that of the extrudate) was used by adjusting the speed of the take-up device. The roll temperature was kept at about 40°C by cooling water. Subsequently, the extrudate was immediately quenched in cold water (20 °C) after stretching. The weight ratios of OBC/PP were fixed at 90/10.

To prepare the tensile testing specimens, an injection molding machine PS40E5ASE (NISSEI, Japan) was used. To preserve the original fibrillar morphology of PP in the composites, the barrel with three sections and nozzle temperatures the injection molding machine were controlled at 130, 140, 140 and 140°C， respectively.

2.3 Scanning electron microscope (SEM)

The scanning electron microscopy (SEM) experiments were performed using an FEI Inspect F SEM instrument with an acceleration voltage of 20 kV. OBC was etched away by hot xylene at proper temperature.

2.4 Rheological analysis

The melt rheology of OBC/PP composites was measured in a strain-controlled dynamic rheometer (Bohlin Gemini 2000, Malvern, British). For the measurement, disk-like samples obtained from the compression molding of the extrudates at 140 °C were used with diameters of 25 mm and thickness of 2 mm. The testing temperatures were controlled at 140 °C, which is below the T_m of PP. The strain amplitude was set as 1% with the frequency sweep was performed in the range of 0.06-628rad/s.

2.5 Tensile properties

A SANS universal testing machine (Shenzhen, China) was used to measure the tensile properties. Tensile measurements were made on dumbbell shape specimens 10.2 mm wide, 4.24 mm thick with a gauge length of 100 mm. A crosshead speed of 50 mm/min was applied to determine the tensile properties.

3 Calculation of viscosity ratio

The mass velocity is about 1.13 kg/h and the density is about 0.90 g/cm3, the q is calculated about 347 mm^3/s. r is 1.5mm. So the apparent shear rate $\dot{\gamma}$ is about 131 s^{-1} according to the following equation:

$$G \approx \dot{\gamma} = 4Q / \pi r^3$$