be undesirable that these potential problems impaired the advantages of using NFs such as environmental friendliness and safety factors. The ideal situation is that good properties or acceptable performance were obtained by using the NFs directly as reinforcements in composites. NFs have different origins such as cotton, flax, jute, hemp, sisal, ramie, bark, wood, nut shells, bagasse, corncobs, bamboo and cereal straw. Compared with conventional fibers, NFs provide many advantages: good mechanical properties, low cost and abundance, biodegradability, low density, renewability, non-abrasiveness to processing equipment and that incorporating the tough and light-weight NFs into polymer (thermoplastic or thermoset) matrices produces composites with good properties[3].

Compared with the pure polymer, if the properties of the untreated natural fibers/polymer composites remain at the same level, even mechanical properties of composites are slightly decreased; the composites are economically feasible and still competitive in the market, such as plastics and packaging industries, for lower price and low density of NFs.

Lots of studies focused on the tensile/flexural and impact strength of the NFs/polymer composites[3,4,6,7,9]. So far, not much attention has been paid to the vicat softening temperature, dimensional stability and other properties of unmodified RF as reinforcement by melt processing with thermoplastics matrix. And these properties should also be considered for practical applications of composites.

In the present study, polypropylene (PP) was used as matrix for their good properties and relatively low processing temperature which was essential because of low thermal stability of natural fibers. Commonly known as China grass, ramie is widely planted in both southern and northern China, used without modified as reinforcement. The effects of RF loading on some physical and mechanical properties of PP/RF composites were evaluated. We tried to prepare the composites with high vicat softening temperature and good dimensional stability by using unmodified RF as reinforcements. The purpose of this work is to give a facile and economic preparation and give a new insight into unmodified natural fiber-reinforced PP composites with acceptable performance.

2 Experimental

2.1 Materials

The ramie fibers (RF) were provided by Lu’An Hualong Hemp Spinning Crafts Co. Ltd, China. RF was cut with an average length of 10 mm before use. The matrix PP (T30S) was provided by Daqing Petrochemical Company, China. All the materials were dried at 110 ℃ for more than 6 hours before use.

2.2 Composites preparation

The samples of PP/RF composites were prepared with a melting hybrid technology. Firstly, the RF and PP were mixed homogeneously with a double-roller blending rolls, and then the mixed material was hot pressed into board by a hot pressing machine. Finally, the standard samples for mechanical property test were prepared by sawing or milling from the board. A series of composites with different RF contents were prepared.

2.3 Characterization

2.3.1 Morphology

The surface morphology of RF and fractured surfaces of composites were observed by a Quanta 200 FEG Environmental Scanning Electron Microscopy (SEM) system. All samples were gold coated prior to being loaded into the SEM chamber.

2.3.2 Thermal behaviors

The thermal behaviors of the composites were investigated using differential scanning calorimetry (DSC) and Thermal gravimetric analysis (TGA). DSC studies were carried out using a Q100 instrument (TA instruments, USA) in a nitrogen atmosphere. All samples were heated to 190 ℃ and held for 5 min to eliminate the influence of thermal history. A scanning rate of 10 ℃/min was adopted. The weight of the samples was about 5-10 mg. TGA studies were carried out using a Q-5000 IR instrument (TA instruments, USA) in an nitrogen atmosphere at a heating rate of 10 ℃/min. The temperature range used for the analysis was 40-700 ℃.

2.3.3 Mechanical properties

Tensile strength was determined out with an electronic universal testing machine (CMT6101, Shenzhen Sans Testing Machine Co., Ltd., China) at a speed of 10 mm/min according to GB/T 1040.2-2006.

Charpy notched impact strength was measured by using a XCJ-4 Impact Tester, according to GB/T 1043.1-2008. More than five specimens were tested for each test and the average data have been reported.

2.3.4 Vicat softening temperature

The vicat softening temperature was determined with a HDT-VICAT tester (ZWK1302-B, Shenzhen SANS Testing Machine Co., Ltd., Shenzhen, China) based on GB/T 1633-2000. Tests were conducted at 10 N loads from room temperature up to 200 ℃ at a