Doctor Thesis

# Study on the Mechanical and Interfacial Property of Injection Molded Fiber Reinforced Thermoplastics

王　存涛

## Abstract

Fiber reinforced polymer (FRP) composites have been used widely in the land transportation, aerospace, marine structures and characteristically conservative infrastructure construction industries and generally, the interface plays very important role in the properties of FRP materials. Therefore, this research studied the mechanical and interfacial property involved in the non-weld samples, weld samples and adhesive samples of insert moldings.

Green composites as one of environment-friendly materials are becoming more and more attractive. The control of environmental pollution, the high performance properties and the recycling opportunity make thermoplastic polymers very attractive. The combination of thermoplastics and renewable natural fibers such as jute fibers as reinforcement in composites will answer the demand of environmental friendly materials. Jute fibers have several specific advantages including low cost, high and comparable specific mechanical properties, excellent biodegradability, and good thermal and acoustic insulation. On the other hand, due to the good biodegradability and good recyclability, mechanical properties and light weight, polylactic acid (PLA) and polypropylene (PP) has been widely used in many aspects, such as automotive parts and house furnishings. Injection molding is one of the most attractive mass production methods for plastic parts in industry owing to its high production rate, short cycle times and low percentage of scrap, available and versatile moulds. However, weld line is one of the typical problems seen in injection molding. The presence of weld lines not only detracts from the surface quality but also significantly reduces the mechanical strength of injection-molded parts. In this research, firstly it studied the mechanical properties of injection molded jute/PLA and jute/PP with or without weld line. The Kelly-Tyson model was used to estimate the interfacial property of injection molded jute/PLA and jute/PP with or without weld line. The method of increasing-holding pressure and re-compounding technology were used to improve the mechanical and interfacial property of injection molded jute/PLA and jute/PP with or without weld line.

Glass reinforced polypropylene (GF/PP) composites are the most widely used fiber reinforced thermoplastic because of their excellent mechanical property, good processability and low cost. Many research works have been carried out to investigate the interfacial shear property in the FRP composites, but very few reports on interfacial tension property in FRP materials can be found. As a subsequence, a novel method was established to evaluate the interfacial tension property in the injection molded GF/PP composites based on the characteristic of fiber orientation in the weld samples. In addition, the effect of weld line and scratch on the impact property of injection molded PP and polycarbonate (PC) plate was investigated based on the drop impact test and fracture surface observation.

In order to short-cut the production processing and reduce energy consumption, direct fiber feeding injection molding technology regardless of pelletizing process was established in this research. Kelly-Tyson model and nano indenter instrument were adopted to do comparative research on the interfacial property of carbon fiber reinforced polycarbonate (CF/PC) fabricated by direct fiber feeding injection molding technology.

Insert-molding is the injection molding process where one material is molded onto a second material. If properly selected, the two kinds of materials will form a strong bond. Therefore, the use of primers or adhesives is no longer required to achieve an optimum bond between the two materials. In the final of this research, the interface adhesive property of GF/PP and GF/PC dumbbells molded by insert molding method were estimated based the tensile test, differential scanning calorimeter (DSC) and morphology observation by the scanning electron microscope (SEM).