# STUDY ON CALCIUM CARBONATE REINFORCED PEEK

*ZhouBing YuChuang Xiangbo Ji and Zhenhua Jiang*

Institute of Chemistry
Jilin University,Changchun,130023,P.R. China

## Introduction

A variety of inorganic materials, such as glass fibers, talc, calcium carbonate, and clay materials, have been successfully used as addictives or reinforcement to improve the stiffness and strength of the polymers. The extent of property enhancement depends on many factors including the aspect ratio of the fillers, its degree of dispersion and orientation in the matrix and the adhesion at the matrix-filler interface. PEEK is a high performance thermoplastic with Tg of 143℃and Tm of 343 ℃. Its superior mechanical properties and excellent resistance to hydrolysis has resulted in its extensive usage as structural and load bearing materials in the aerospace and marine industries. This study was carried out on the composites consisting of nanoscopic calcium carbonate fillers embedded in PEEK via direct melt compounding using a conventional twin screw extruder. In this process sulfonated PEEK was introduced as a modifier of calcium carbonate powder. The mechanical properties and thermal properties of the composites were characterized. Calcium carbonate in this system can not only improve the properties of the composites but also lower their value and enhance their fire-retardency because of the high decomposing temperature of the fillers.

## Experimental

**Materials.** PEEK was supported by Jilin University Huaxing Science and Technology Development Company. Sulfonated PEEK (S-PEEK) was self-made. And also was calcium carbonate with an average diameter of 200nm.

**Instrumentation.** Differential scanning calorimetry (DSC) was used to analysis the thermal properties of the composites. The tests were done on a Mettler Toledo 821$^e$ DSC. And Instron 1211 was used to determine the mechanical properties of the composites. And according to X-ray diffraction data, the filler is pure calcite.

**Preparation of the composites.** Surface treatment was carried out in solution. 50g $CaCO_3$ was suspended in 500ml water and 2g S-PEEK was added during intensive stirring. Mixing time was one hour at 80℃. $CaCO_3$ was dried for 24 hours at 120℃. A series of composites were prepared from the $CaCO_3$ treated with and without S-PEEK and PEEK through melt compounding. The mass ratio of filler/matrix is from 0.05~0.25.

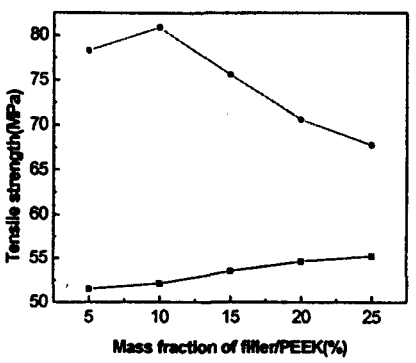


**Figure 1 Tensile strength of PEEK/$CaCO_3$ composites plotted against their filler contents.**

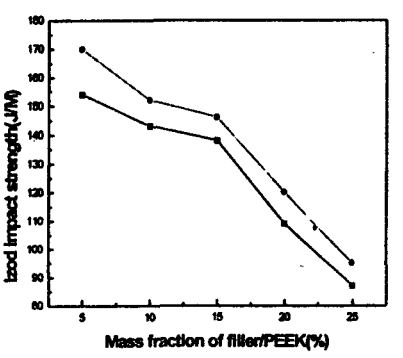


**Figure 2 Izod impact strengh of PEEK/$CaCO_3$ composites plotted against their filler contents.**

**Results and Discussion.** The mechanical properties were much affected by treatment since at larger deformations the mobility of the interfacial region influences the performance of the composites. As was shown in figure1-3.

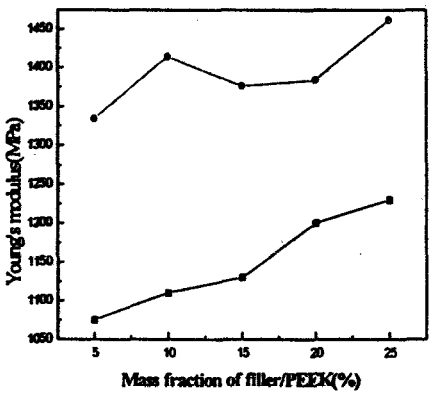


**Figure 3 Young's modulus of PEEK/$CaCO_3$ composites plotted against their filler contents.**
Symbols: ●modified with S-PEEK ■no treatment

From figure1~3, it can be obviously seen that the mechanical properties of the composites were significantly influenced by the extent of the interfacial adhesion between the filler and the matrix. S-PEEK can effectively improve the scattering of $CaCO_3$ in PEEK. Therefore, the mechanical properties were better than those without S-PEEK at the same ratio of filler/matrix.

The thermal properties of the PEEK/$CaCO_3$ composites were shown in the following table.

| Ratio of $CaCO_3$/ PEEK | 0 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| Tg(℃) | 144.3 | 152.7 | 146.7 | 146.2 | 147.2 | 147.4 |
| Tm(℃) | 333.5 | 332.5 | 331.3 | 330.9 | 329.4 | 332.1 |
| T*g(℃) | 144.3 | 146.1 | 145.8 | 145.6 | 146.8 | 146.1 |
| T*m(℃) | 333.5 | 328.9 | 328.8 | 325.9 | 325.8 | 325.7 |

Symbol *: $CaCO_3$ was treated with S-PEEK before padded into PEEK matrix.

This table indicated that the fillers had changed the original thermal properties through the increase of Tm and the decrease of Tm. And S-PEEK made $CaCO_3$ more miscible in PEEK matrix, as proved by the table that both Tg and Tm are lower than those without the modifiers at the same content of $CaCO_3$.

**Conclusions** Particulate composites of PEEK had perfect mechanical and thermal properties. S-PEEK can improve the surface properties of $CaCO_3$ and made the fillers more easily scattering in PEEK matrix.

**References**

(1) F.Rahma, Polymer Composites,21(2),175(2000)