# Study on PEEK/Montmorillonite Nanocomposites (Ⅱ)

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**Keywords:** montmorillonite, nanocomposites , melt-blending

The high performance poly(ether-ether-ketone) (PEEK) was first prepared by Bonner in 1962[1]. PEEK has a glass transition temperature (Tg) of 145°C, a melting point (Tm) of 335°C and resistant heat of long-term beyond 250°C depending on the relative proportion of ether-ketone groups linking the phenylene rings[2]. In addition, PEEK has outstanding mechanical properties, electrical properties, endurable chemical cautery, resistant radicalization and resistant weariness.

Since the Toyota research group reported nylon 6(N6)/clay nanocomposites in 1990s, the field of polymer/clay nanocomposites (PCNs) has attracted wide attention in the past decade. Polymer-layered silicate nanocomposites containing low levels of exfoliated clays have a structure consisting of platelets with at least one dimension in the nanometer range. The platelet aspect ratio exceeds 300, giving rise to a high degree of polymer–clay surface interaction which results in barrier and mechanical properties that are far superior to those of the pure resin and macro-composites [3-12].

Once we applied this method to PEEK, and prepared PEEK/montmorillonite composites. The mechanical properties of composites materials using different producing area montmorillonites were studied. As a result, there is no obvious difference among the mechanical properties of composites using different producing area montmorillonites. In this work, we modify montmorillonite with sulfonated-PEEK(SPEEK)、γ-aminopropyl triethoxy silane (KH-550)、cetyltrimethyl ammonium bromide (CTAB), and study the effect of different modifier on the composites.

## 1 Experimental

### 1.1 materials

PEEK resin was supplied by Engineering Research Center of High Performance Plastics, Ministry of Education, Jilin University, and melt index of PEEK was 21g/10min（400℃，5kg shear stress）; montmorillonite with cation exchange capacity (CEC) 90mmol/100g was manufactured by Zhejiang Fenghong Clay Chemicals Co. Ltd; Cetyltrimethyl ammonium bromide was obtained from Shanghai Huishi Chemical Co. Ltd; SPEEK was prepared in our lab，the degree of sulfonated was 70%; KH-550 was supplied by Nanjing Chuangshi Chemical Co. Ltd.

### 1.2 Preparation of PEEK/MMT nanocomposites

OMMTs modified in 80℃ water were filtrated, dried in a vacuum oven, then ground into ultrafine powder. OMMTs and the pure PEEK were blended in a Haake PTW16/25p co-rotating twin-screw extruder, with 350℃ of the compounding temperature and 90 rpm of the screw speed. Injection samples were obtained using a SZ15 plunger injection molding machine (Shanghai Light Industry and Machinery Co. Ltd).

### 1.3 Characterization

The WAXD was performed with a Raguku Model D/max-2550 diffractometer. The Cu Kα radiation source was operated at 40 kV and 350 mA($\lambda$ = 0.154 nm). Tensile properties of the samples were measured using a Shimadzu AG-1 tensile testing machine. The fracture surfaces of the samples were observed with a Shimadzu SSX-550 Superscan scanning electron microscope.

## 2 Results and Discussion

### 2.1 XRD analysis

XRD of the unmodified MMT and modified MMTs with SPEEK, KH-550 and CTAB was shown in Figure.1 In the case of the unmodified MMT, the interlamellar spacing of the clay is 1.24 nm. In the case of the modified MMT with CTAB, the interlamellar spacing of the clay is 2.05nm. As for the modified MMTs with SPEEK and KH-550, there is no obvious peak displacement. This shows that the long chain alkylammonium ions can intercalate between the layers during the cation exchange, while SPEEK and KH550 can't result in the similar effect.

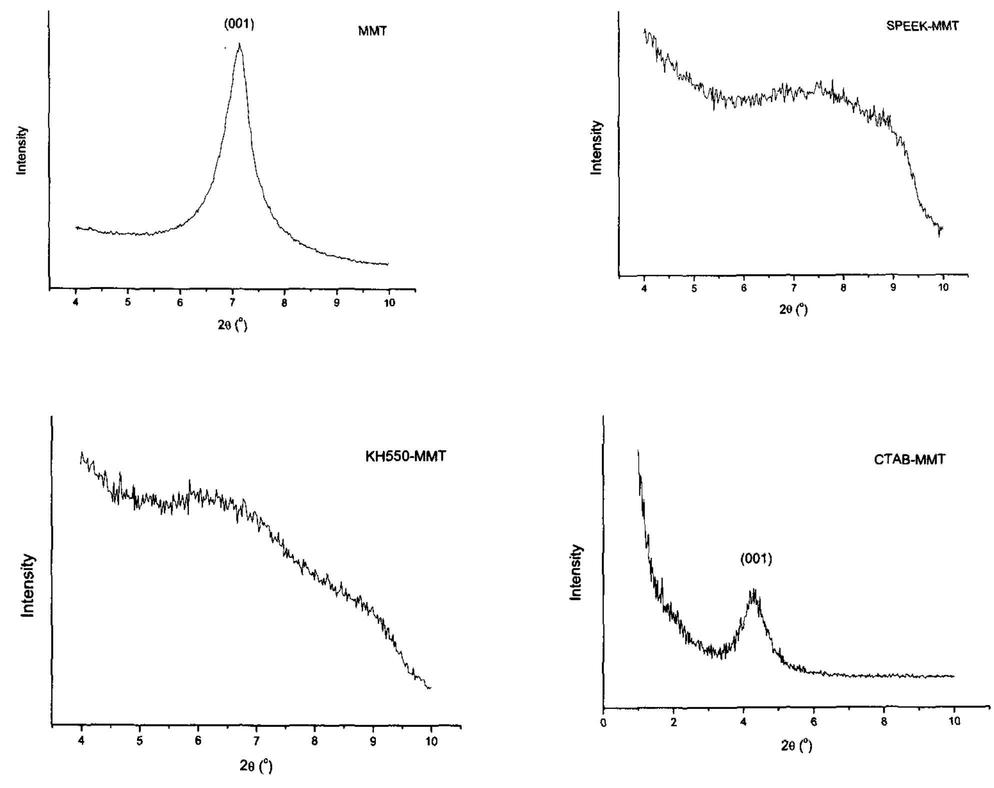


**Figure 1.** XRD of the unmodified and modified MMTs

### 2. 2 Mechanical properties of PEEK/OMMT nanocomposites

Mechanical properties of PEEK/OMMT nanocomposites were showed in Table 1. PEEK/OMMT nanocomposites showed higher modulus and higher strength compared to the pure resin, only the elongation at breakage decreased. The mechanical properties of PEEK/CTAB-MMT were the best among the PEEK/OMMT nanocomposites.

**Table1** Mechanical properties of PEEK/OMMT nanocomposites

| | Flexural modulus (GPa) | Flexural strength (MPa) | Tensile modulus (GPa) | Tensile strength (MPa) | Elongation at break (%) |
|---|---|---|---|---|---|
| PEEK | 3.09 | 150.38 | 1.16 | 92.77 | 73.37 |
| PEEK-MMT | 3.44 | 158.28 | 1.27 | 93.93 | 47.04 |
| PEEK/SPEEK-MMT | 3.62 | 171.11 | 1.29 | 97.69 | 33.97 |
| PEEK/KH550-MMT | 3.66 | 172.93 | 1.25 | 95.41 | 36.52 |
| PEEK/CTAB -MMT | 4.00 | 178.15 | 1.29 | 99.14 | 36.48 |

**2.3 Morphology analysis**

The dispersions of MMT in nanocomposites are presented in Figure2. The dimension of MMT decreases in the order of MMT > SPEEK-MMT ≈ KH550-MMT > CTAB-MMT. This further proves that the modified effect of CTAB was the best.

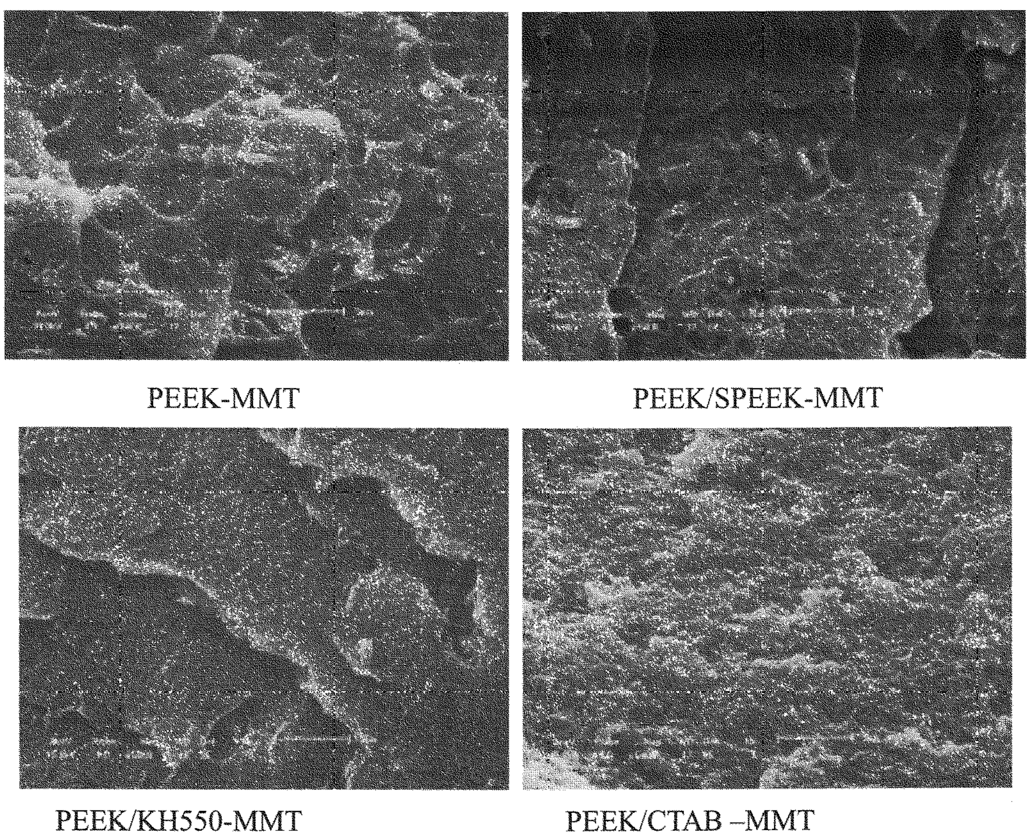


Figure 2. SEM micrographs of PEEK/MMT nanocomposites

**3. Conclusion**

For the unmodified and modified montmorillonite with KH-550、SPEEK and CTAB, we can draw the conclusion that the addition of clay particles improved both modulus and strength of pure PEEK. Moreover, the improvement of modulus and strength of PEEK/CTAB-MMT is the most obvious. Namely a larger intercalation d-spacing and a smaller dimension of MMT can be obtained. In a word, CTAB was the best modifier among SPEEK, KH550 and CTAB.

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