Supporting Information

Highly Thermally Conductive UHMWPE/ Graphite Composites with Segregated Structures

Changping Feng[1], Lei Chen[2], Fang Wei[1], Haiying Ni[1], Jun Chen[1*] and Wei Yang[1, 3*]

1. College of Polymer Science and Engineering, Sichuan University, Chengdu, 610065, Sichuan, China
2. Department of Mechanical and Electronic Engineering, Changsha University
3. State Key Laboratory of Polymer Materials Engineering, Sichuan University, Chengdu, 610065 Sichuan, China

College of Polymer Science and Engineering, Sichuan University, Chengdu, 610065, China

[*] Corresponding authors. Tel.: + 86 28 8546 0130; Fax: + 86 28 8546 0130.

E-mail addresses: cschen@vip.163.com (J Chen) and weiyang@scu.edu.cn (W Yang)

Characterization

The electrical resistance of the composites was measured using a Keithley 4200SCS apparatus. The tensile strength of the composites was determined using a SHIMADZU AGS-J 10KN (Japan) tensile testing machine.

Differential scanning calorimetry (DSC) analysis has been performed using TA Instruments DSC Q1000 in a nitrogen atmosphere. In the non-isothermal experiments the specimens were heated at a rate of 10 °C min^{-1} to 180 °C to eliminate previous thermal history and then cooled down to 30 °C at a rate of 10 °C min^{-1}. Lastly, the specimens were again heated to 180°C at a rate of 10 °C min^{-1}.

Results and discussion

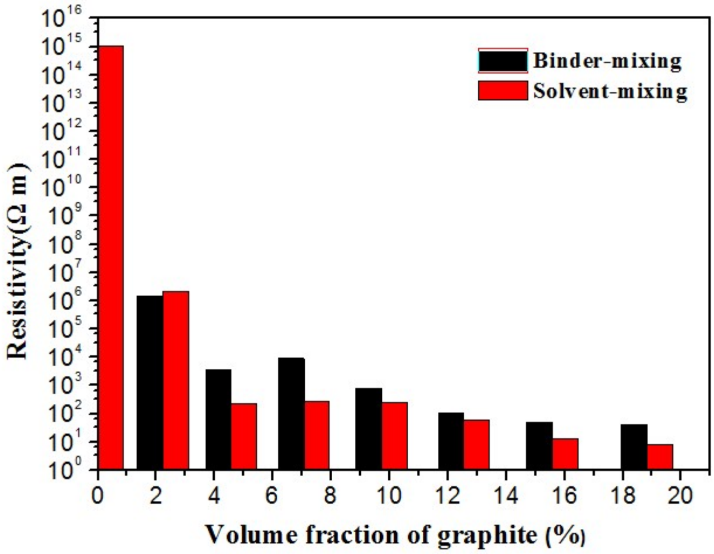

Fig S1. The electric resistivity of UHMWPE/graphite composites with different content of graphite flakes prepared by solvent-mixing method and binder-mixing method

Fig S1 shows the electric volume resistivity of UHMWPE/graphite composites prepared by solvent-mixing method and binder-mixing method. We can see that the introduction of graphite flakes decreases the volume resistivity of all the composites, and when the graphite flakes loading is 2.22vol%, the volume electric resistivity drops sharply from 1×10^{15} to 10^{6} Ω m, which indicates that an electrical conductive network has formed. When the graphite loading increases to 18.83 vol%, the volume electric resistivity of UHMWPE/graphite composites prepared by solvent-mixing method and binder-mixing method declines to 7.6 Ω m and 40.6 Ω m. Obviously, UHMWPE/graphite composites prepared by solvent-mixing method show lower electric resistivity than those fabricated by binder-mixing method. All the UHMWPE/graphite particles prepared by solvent-mixing method and binder-mixing method exhibit a segregated structure. Even though there are some broken points in the network which formed by solvent-mixing method, the electrons can pass through conductive paths owing to the "tunnel effect". While, the volume electric resistivity of UHMWPE/graphite composites prepared by the binder-mixing method is relatively higher because insulated binder was in between the graphite flakes.

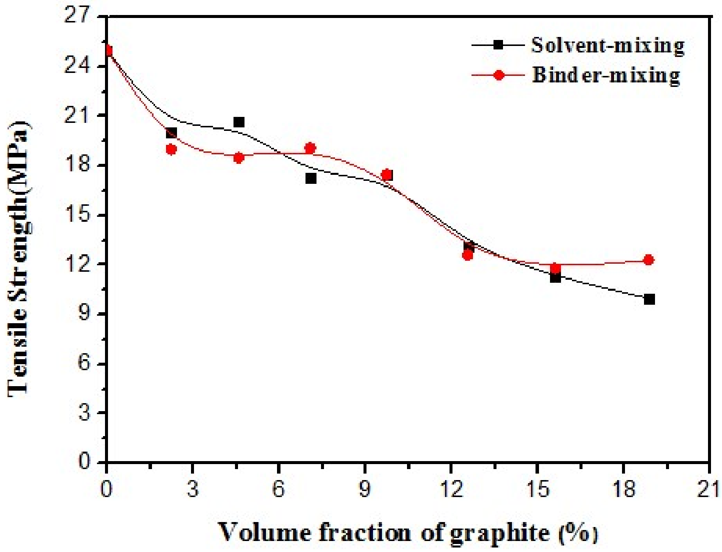

Fig S2. The tensile strength of UHMWPE/graphite composites prepared by solvent-mixing method and binder-mixing method with different content of graphite flakes

We can see that the introduction of graphite flakes decreases the tensile strength of all the composites, and when the graphite flakes loading is 18.83vol%, the tensile strength of UHMWPE/graphite composites prepared by solvent-mixing method and binder-mixing method drops to 12.3 MPa and 10 MPa, respectively. It can be seen that the tensile strength of both series of composites is comparable.

The thermal properties for the melting of neat UHMWPE and UHMWPE/graphite composites fabricated by binder-mixing and solvent-mixing methods are shown in the Fig S3. The corresponding thermal data are listed in Table S1. The melting temperatures of UHMWPE/graphite composites fabricated by binder-mixing and solvent-mixing methods are 136.97 °C and 135.46, respectively and the melting temperatures were virtually affected by the fabricating methods.

The melting heat of fusion is decreased from 124.10 J/g (UHMWPE) to 88.91 J/g (9.72vol%Graphite+Solvent-mixing) and 72.80 J/g (9.72vol%Graphite+Binder-mixing), which indicates the graphite flakes restrict the mobility of the neighboring polymer molecules, hence the crystallinity decreased. The same phenomenon was also reported in literature[1].

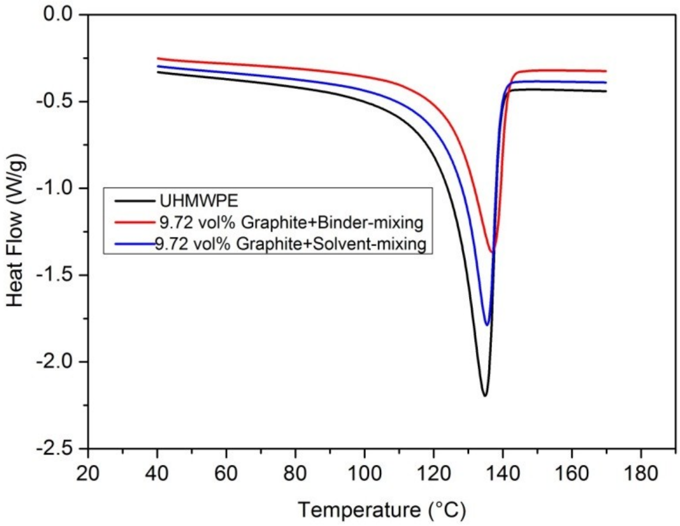

Fig S3 The thermal properties for the melting of neat UHMWPE and UHMWPE/graphite composites fabricated by binder-mixing and solvent-mixing methods

Table S1 Thermal data of neat UHMWPE and UHMWPE/graphite composites fabricated by binder-mixing and solvent-mixing methods from DSC analysis

Sample	T_m (°C)	ΔH_m (J/g)
UHMWPE	134.85	124.10
9.72vol%Graphite+Binder-mixing	136.97	72.80
9.72vol%Graphite+Solvent-mixing	135.46	88.91

References

1. H. Fouad, Rabeh Elleithy. High density polyethylene/graphite nano-composites for total hip joint replacements: Processing and in vitrocharacterization. Journal of the mechanical behavior of biomedical materials. 2011, 4, 1376