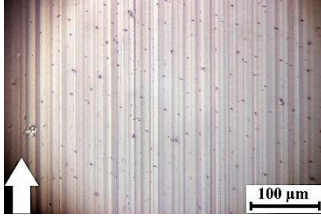


The ceramic-polymer tribological contact

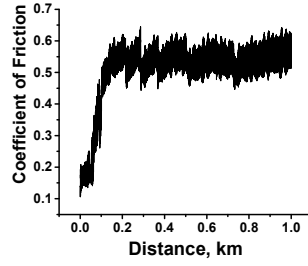
Wear track surface



$R_a=0.380\ \mu\text{m}$,
 $WR=3.89\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.54$, $T=41.0\ ^\circ\text{C}$

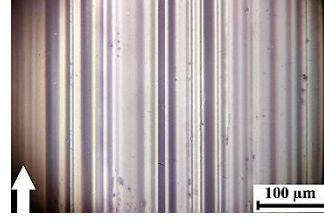
(a)

CoF



(b)

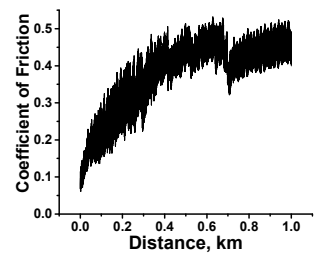
Wear track surface



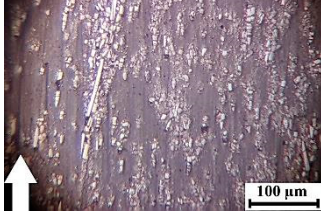
$R_a=0.431\ \mu\text{m}$,
 $WR=1.72\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.44$, $T=38.0\ ^\circ\text{C}$

(c)

CoF

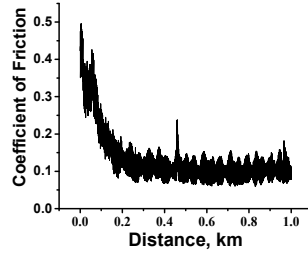


(d)

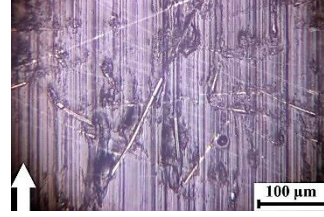


$R_a=0.158\ \mu\text{m}$,
 $WR=2.60\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.12$, $T=32.0\ ^\circ\text{C}$

(e)

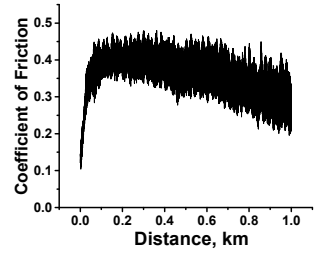


(f)

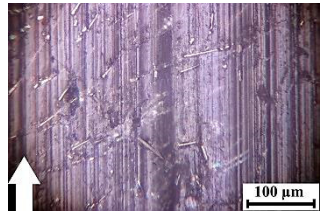


$R_a=0.325\ \mu\text{m}$,
 $WR=10.25\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.37$, $T=33.7\ ^\circ\text{C}$

(g)

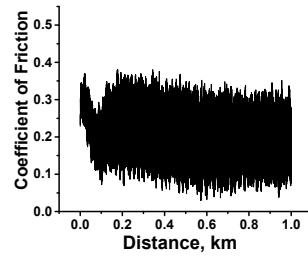


(h)

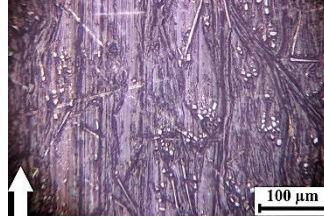


$R_a=0.255\ \mu\text{m}$,
 $WR=20.5\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.21$, $T=32.0\ ^\circ\text{C}$

(i)

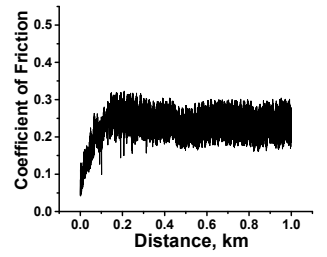


(j)

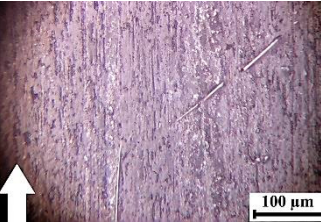


$R_a=0.395\ \mu\text{m}$,
 $WR=12.2\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.23$, $T=32.7\ ^\circ\text{C}$

(k)

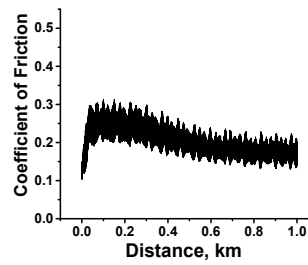


(l)

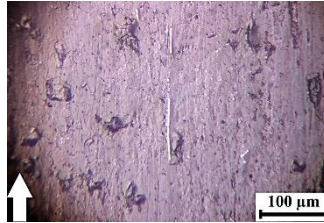


$R_a=0.112\ \mu\text{m}$,
 $WR=0.31\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.18$, $T=31.9\ ^\circ\text{C}$

(m)

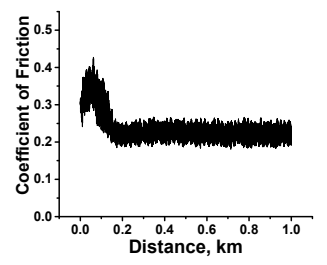


(n)

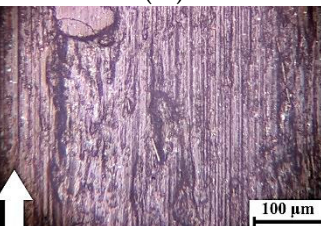


$R_a=0.183\ \mu\text{m}$,
 $WR=1.85\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.22$, $T=32.9\ ^\circ\text{C}$

(o)

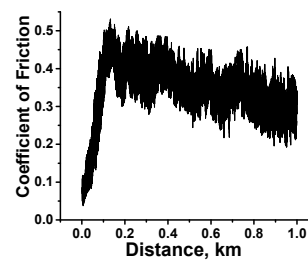


(p)

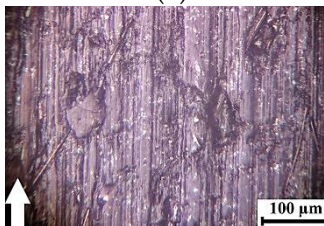


$R_a=0.286\ \mu\text{m}$,
 $WR=9.45\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.34$, $T=35.3\ ^\circ\text{C}$

(q)

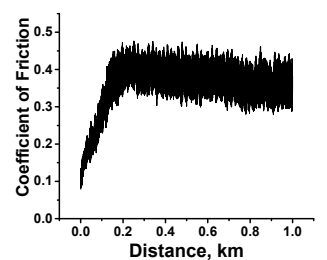


(r)



$R_a=0.418\ \mu\text{m}$,
 $WR=6.7\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.38$, $T=35.6\ ^\circ\text{C}$

(s)

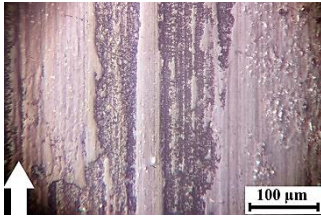


(t)

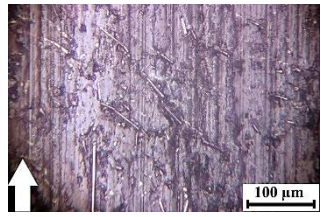
Figure S1. The optical micrographs of the wear track surfaces and the CoF time dependences for neat both PI (**a, b**) and PEI (**c, d**), as well as their PI/10CCF (**e, f**), PI/10CCF/10PTFE (**i, j**), PI/10CCF/10Gr (**m, n**), PI/10CCF/10MoS₂ (**q, r**), PEI/10CCF (**g, h**), PEI/10CCF/10PTFE (**k, l**), PEI/10CCF/10Gr (**o, p**), and PEI/10CCF/10MoS₂ (**s, t**) composites. The ceramic-polymer tribological contact under the 'mild' conditions ($P=60$ N, $V=0.1$ m/s).

Wear track surface

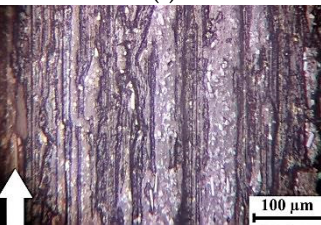
Sample melted
 $WR=368.0 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.51$, $T=184.0 \text{ }^\circ\text{C}$



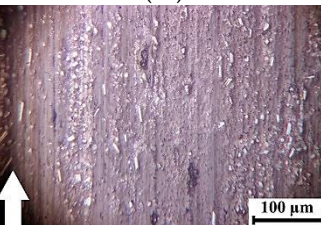
$R_a=0.251 \text{ } \mu\text{m}$,
 $WR=2.86 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.10$, $T=63.0 \text{ }^\circ\text{C}$



$R_a=0.324 \text{ } \mu\text{m}$,
 $WR=15.6 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.26$, $T=80.0 \text{ }^\circ\text{C}$

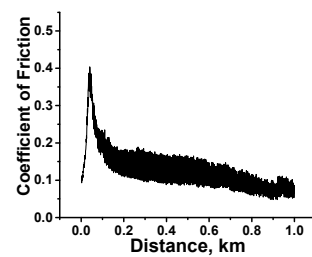
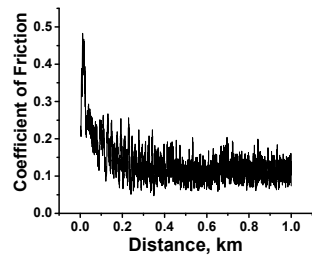
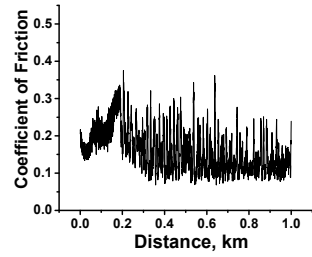
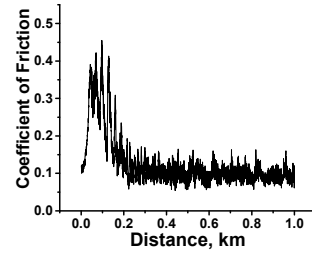
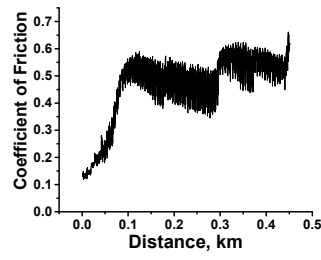


$R_a=0.436 \text{ } \mu\text{m}$,
 $WR=5.6 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.10$, $T=70.0 \text{ }^\circ\text{C}$

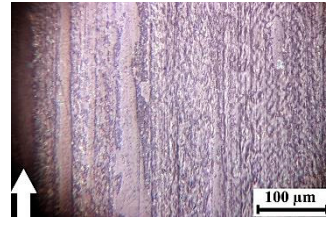


$R_a=0.256 \text{ } \mu\text{m}$,
 $WR=1.34 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.08$, $T=52.8 \text{ }^\circ\text{C}$

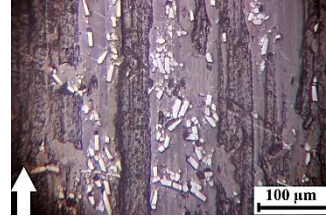
CoF



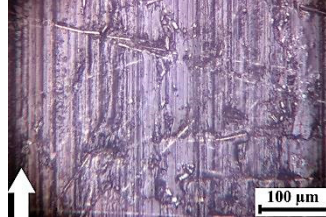
Wear track surface



$R_a=0.201 \text{ } \mu\text{m}$,
 $WR=52.8 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.17$, $T=100.0 \text{ }^\circ\text{C}$



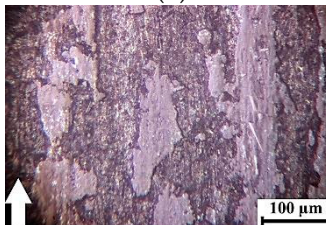
$R_a=0.303 \text{ } \mu\text{m}$,
 $WR=5.5 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.10$, $T=55.7 \text{ }^\circ\text{C}$



$R_a=0.334 \text{ } \mu\text{m}$,
 $WR=61.8 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.15$, $T=89.0 \text{ }^\circ\text{C}$



$R_a=0.487 \text{ } \mu\text{m}$,
 $WR=3.43 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.10$, $T=62.0 \text{ }^\circ\text{C}$



$R_a=0.509 \text{ } \mu\text{m}$,
 $WR=10.0 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.10$, $T=74.6 \text{ }^\circ\text{C}$

CoF

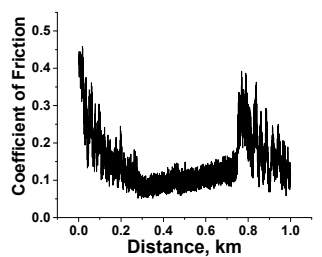
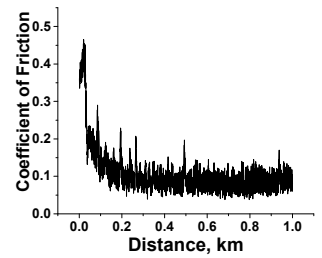
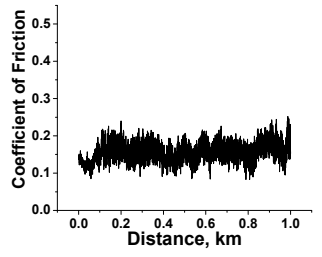
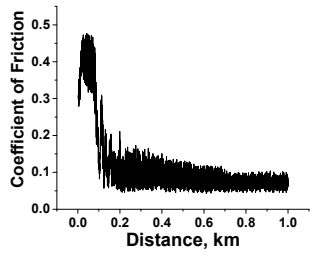
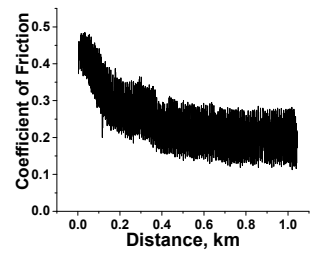
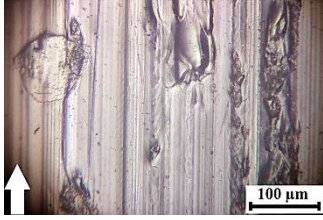


Figure S2. The optical micrographs of the wear track surfaces and the CoF time dependences for neat both PI (**a, b**) and PEI (**c, d**), as well as their PI/10CCF (**e, f**), PI/10CCF/10PTFE (**i, j**), PI/10CCF/10Gr (**m, n**), PI/10CCF/10MoS₂ (**q, r**), PEI/10CCF (**g, h**), PEI/10CCF/10PTFE (**k, l**), PEI/10CCF/10Gr (**o, p**), and PEI/10CCF/10MoS₂ (**s, t**) composites. The ceramic-polymer tribological contact under the 'severe' conditions (P=180 N, V=0.5 m/s).

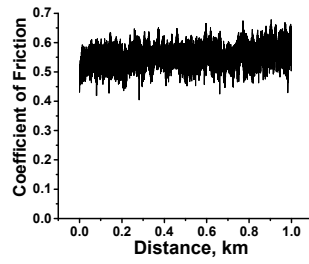
Wear track surface



$R_a=0.389 \mu\text{m}$,
 $WR=33.6 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.50$, $T=28.6 \text{ }^\circ\text{C}$

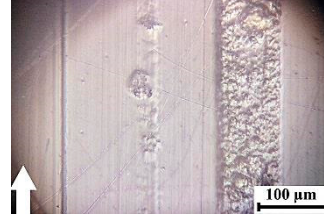
(a)

CoF



(b)

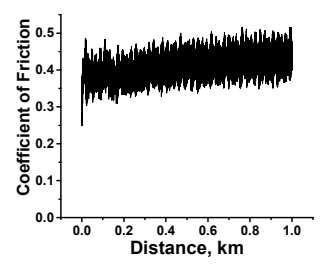
Wear track surface



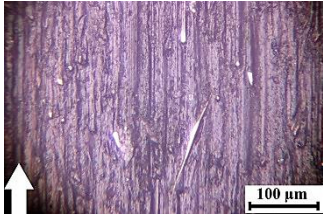
$R_a=0.098 \mu\text{m}$,
 $WR=7.71 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.41$, $T=26.6 \text{ }^\circ\text{C}$

(c)

CoF

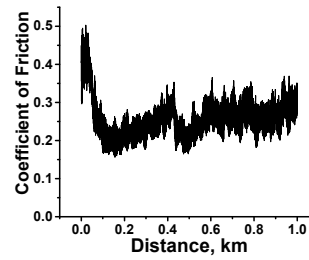


(d)

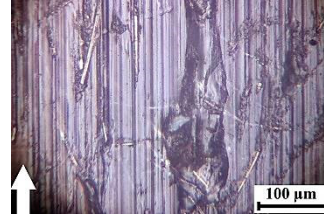


$R_a=0.505 \mu\text{m}$,
 $WR=2.5 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.26$, $T=26.0 \text{ }^\circ\text{C}$

(e)

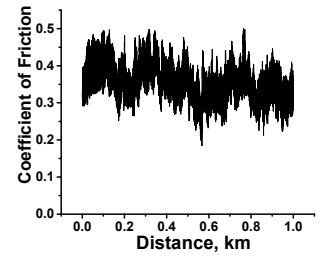


(f)

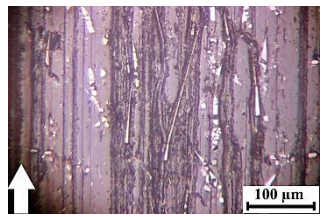


$R_a=0.446 \mu\text{m}$,
 $WR=13.6 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.35$, $T=27.8 \text{ }^\circ\text{C}$

(g)

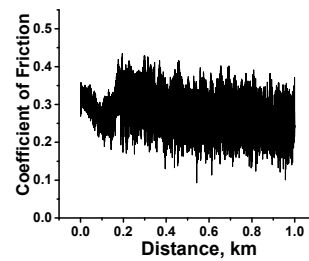


(h)

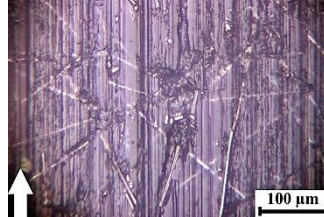


$R_a=0.446 \mu\text{m}$,
 $WR=31.5 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.28$, $T=24.6 \text{ }^\circ\text{C}$

(i)

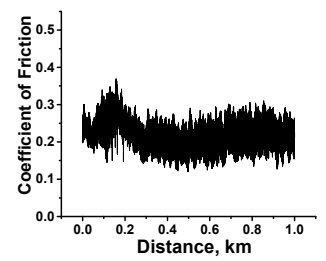


(j)

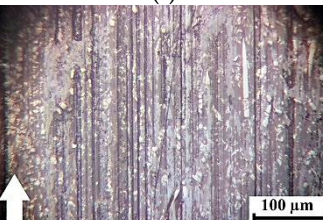


$R_a=0.352 \mu\text{m}$,
 $WR=13.4 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.22$, $T=25.9 \text{ }^\circ\text{C}$

(k)

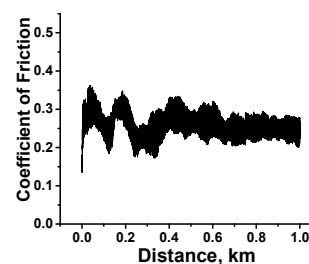


(l)



$R_a=0.270 \mu\text{m}$,
 $WR=1.86 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.25$, $T=26.9 \text{ }^\circ\text{C}$

(m)

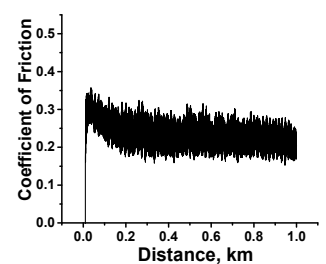


(n)

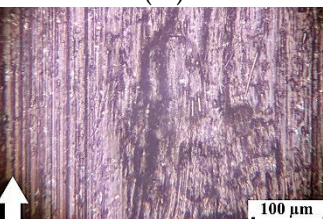


$R_a=0.260 \mu\text{m}$,
 $WR=1.7 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.23$, $T=24.9 \text{ }^\circ\text{C}$

(o)

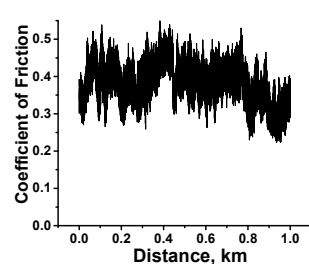


(p)

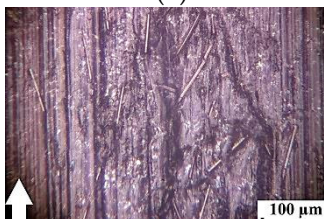


$R_a=0.556 \mu\text{m}$,
 $WR=4.32 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.38$, $T=23.7 \text{ }^\circ\text{C}$

(q)

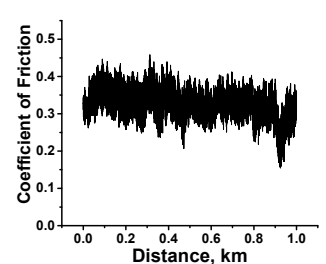


(r)



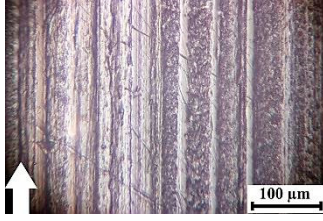
$R_a=0.382 \mu\text{m}$,
 $WR=6.64 \cdot 10^{-6} \text{ mm}^3/\text{N} \cdot \text{m}$,
 $f=0.33$, $T=27.2 \text{ }^\circ\text{C}$

(s)

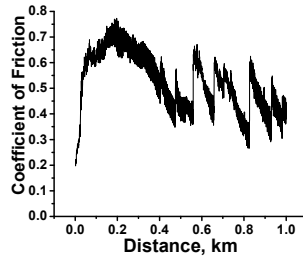


(t)

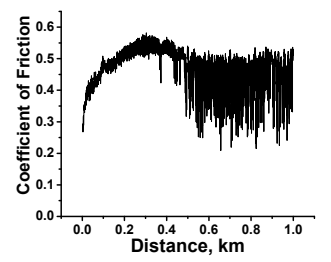
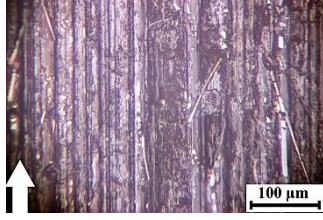
Figure S3. The optical micrographs of the wear track surfaces and the CoF time dependences for neat both PI (**a, b**) and PEI (**c, d**), as well as their PI/10CCF (**e, f**), PI/10CCF/10PTFE (**i, j**), PI/10CCF/10Gr (**m, n**), PI/10CCF/10MoS₂ (**q, r**), PEI/10CCF (**g, h**), PEI/10CCF/10PTFE (**k, l**), PEI/10CCF/10Gr (**o, p**), and PEI/10CCF/10MoS₂ (**s, t**) composites. The metal-polymer tribological contact under the ‘mild’ conditions ($P=60$ N, $V=0.1$ m/s).

Wear track surface

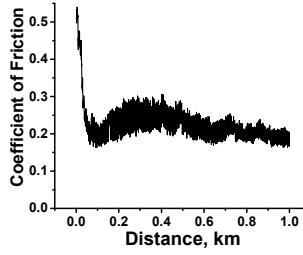
$R_a=0.250\ \mu\text{m}$,
 $WR=68.3\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.52$, $T=55.0\ ^\circ\text{C}$

(a)**CoF****(b)****Wear track surface**

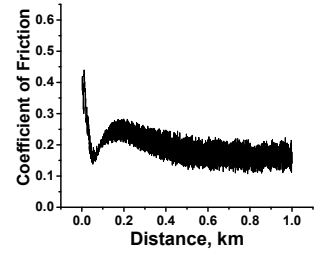
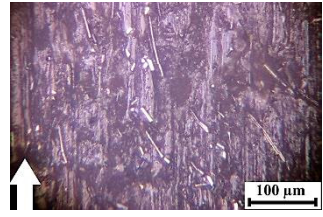
$R_a=0.215\ \mu\text{m}$,
 $WR=32.6\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.47$, $T=54.0\ ^\circ\text{C}$

(c)**CoF****(d)**

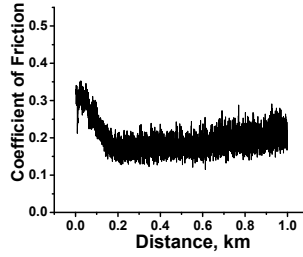
$R_a=0.333\ \mu\text{m}$,
 $WR=3.1\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.23$, $T=34.0\ ^\circ\text{C}$

(e)**(f)**

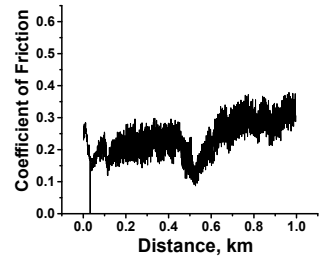
$R_a=0.231\ \mu\text{m}$,
 $WR=1.5\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.17$, $T=36.0\ ^\circ\text{C}$

(g)**(h)**

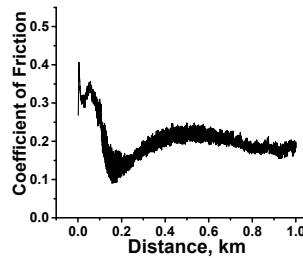
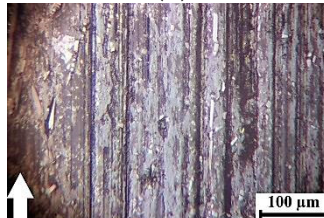
$R_a=0.297\ \mu\text{m}$,
 $WR=56.1\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.20$, $T=51.0\ ^\circ\text{C}$

(i)**(j)**

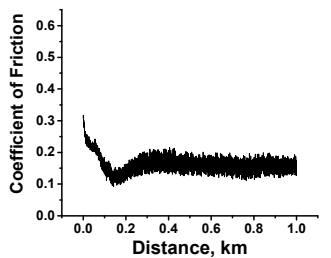
$R_a=0.188\ \mu\text{m}$,
 $WR=27.2\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.31$, $T=53.0\ ^\circ\text{C}$

(k)**(l)**

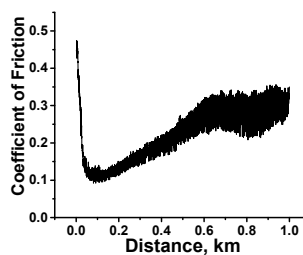
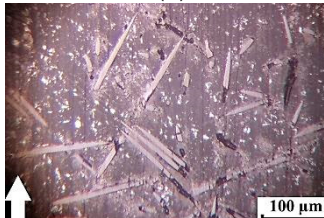
$R_a=0.253\ \mu\text{m}$,
 $WR=1.3\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.20$, $T=38.0\ ^\circ\text{C}$

(m)**(n)**

$R_a=0.229\ \mu\text{m}$,
 $WR=2.3\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.16$, $T=29.0\ ^\circ\text{C}$

(o)**(p)**

$R_a=0.258\ \mu\text{m}$,
 $WR=1.6\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.23$, $T=45.0\ ^\circ\text{C}$

(q)**(r)**

$R_a=0.160\ \mu\text{m}$,
 $WR=1.3\cdot 10^{-6}\ \text{mm}^3/\text{N}\cdot\text{m}$,
 $f=0.15$, $T=32.0\ ^\circ\text{C}$

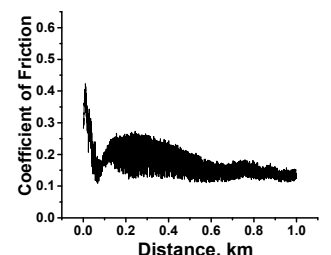
(s)**(t)**

Figure S4. The optical micrographs of the wear track surfaces and the CoF time dependences for neat both PI (**a, b**) and PEI (**c, d**), as well as their PI/10CCF (**e, f**), PI/10CCF/10PTFE (**i, j**), PI/10CCF/10Gr (**m, n**), PI/10CCF/10MoS₂ (**q, r**), PEI/10CCF (**g, h**), PEI/10CCF/10PTFE (**k, l**), PEI/10CCF/10Gr (**o, p**), and PEI/10CCF/10MoS₂ (**s, t**) composites. The metal-polymer tribological contact under the 'severe' conditions (P=180 N, V=0.5 m/s).

Table S1. The results of EDS analysis on the wear track surfaces shown in Figure 8, a–c.

Element	Spectrum 1 at. %	Spectrum 2 at. %	Spectrum 3 at. %	Spectrum 4 at. %	Spectrum 5 at. %
PI					
C	70.99	70.38	62.48	66.42	70.60
O	26.09	26.74	33.69	29.96	26.27
S	2.81	2.79	3.43	1.41	2.80
Fe	0.10	0.09	0.39	2.21	0.33
PI/10CCF					
C	5.08	70.00	13.22	71.05	21.65
O	59.48	26.63	46.06	25.32	49.40
S	2.43	3.27	1.92	3.48	1.58
Fe	33.00	0.10	38.80	0.15	27.37
PI/10CCF/10Gr					
C	0.46	13.991	73.74	15.47	6.06
O	61.39	58.44	23.02	31.02	59.47
S	2.08	3.09	0.94	4.22	3.12
Fe	36.07	24.57	2.30	49.28	31.36

Table S2. The results of EDS analysis on the wear track surfaces shown in Figure 8, d–f.

Element	Spectrum 1 at. %	Spectrum 2 at. %	Spectrum 3 at. %	Spectrum 4 at. %	Spectrum 5 at. %
PEI					
C	63.40	63.48	61.47	62.39	64.17
O	36.60	36.52	38.53	37.61	35.83
PEI/10CCF					
C	34.73	87.16	17.81	20.23	46.19
O	38.82	12.39	52.60	53.80	36.50
Fe	26.46	0.45	29.60	25.97	17.30
PEI/10CCF/10Gr					
C	9.85	21.42	74.22	1.78	7.47
O	58.96	50.67	25.61	61.44	63.10
Fe	31.20	27.91	0.17	36.78	29.43

Table S3. The results of EDS analysis on the wear track surfaces shown in Figure 9, a–c.

Element	Spectrum 1 at. %	Spectrum 2 at. %	Spectrum 3 at. %	Spectrum 4 at. %	Spectrum 5 at. %
PI					
C	65.51	71.60	68.77	68.82	67.87
O	29.86	25.63	27.92	27.79	28.86
S	4.63	2.77	3.31	3.40	3.28
PI/10CCF					
C	69.43	63.53	91.44	70.23	71.14
O	27.75	31.90	7.68	26.26	24.79
S	2.82	4.56	0.89	3.51	4.06
PI/10CCF/10Gr					

C	60.38	45.65	62.43	78.04	72.30
O	38.12	47.99	32.82	17.54	25.43
S	1.34	2.44	3.45	4.30	2.27

Table S4. The results of EDS analysis on the wear track surfaces shown in Figure 9, d–f.

Element	Spectrum 1 at. %	Spectrum 2 at. %	Spectrum 3 at. %	Spectrum 4 at. %	Spectrum 5 at. %
PEI					
C	76.09	71.63	73.35	70.78	72.66
O	23.91	28.37	26.65	29.22	27.34
PEI/10CCF					
C	76.48	74.29	76.21	76.58	73.94
O	23.52	25.71	23.79	23.42	26.06
PEI/10CCF/10Gr					
C	76.37	84.66	82.02	77.73	73.89
O	23.63	15.34	17.98	22.27	26.11