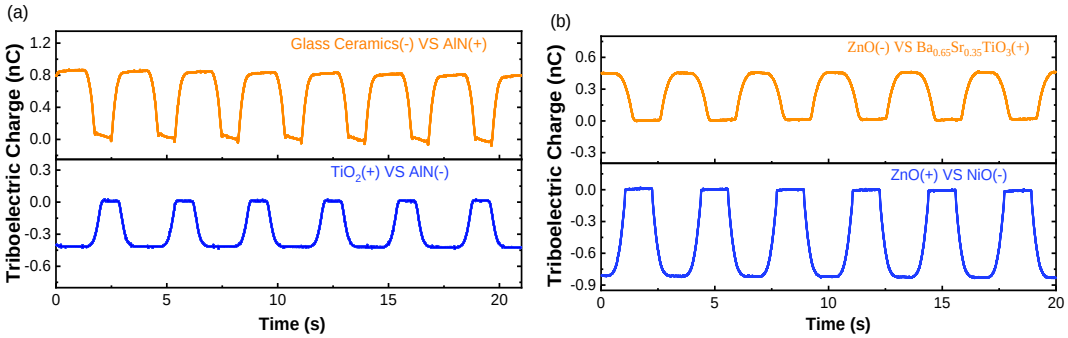
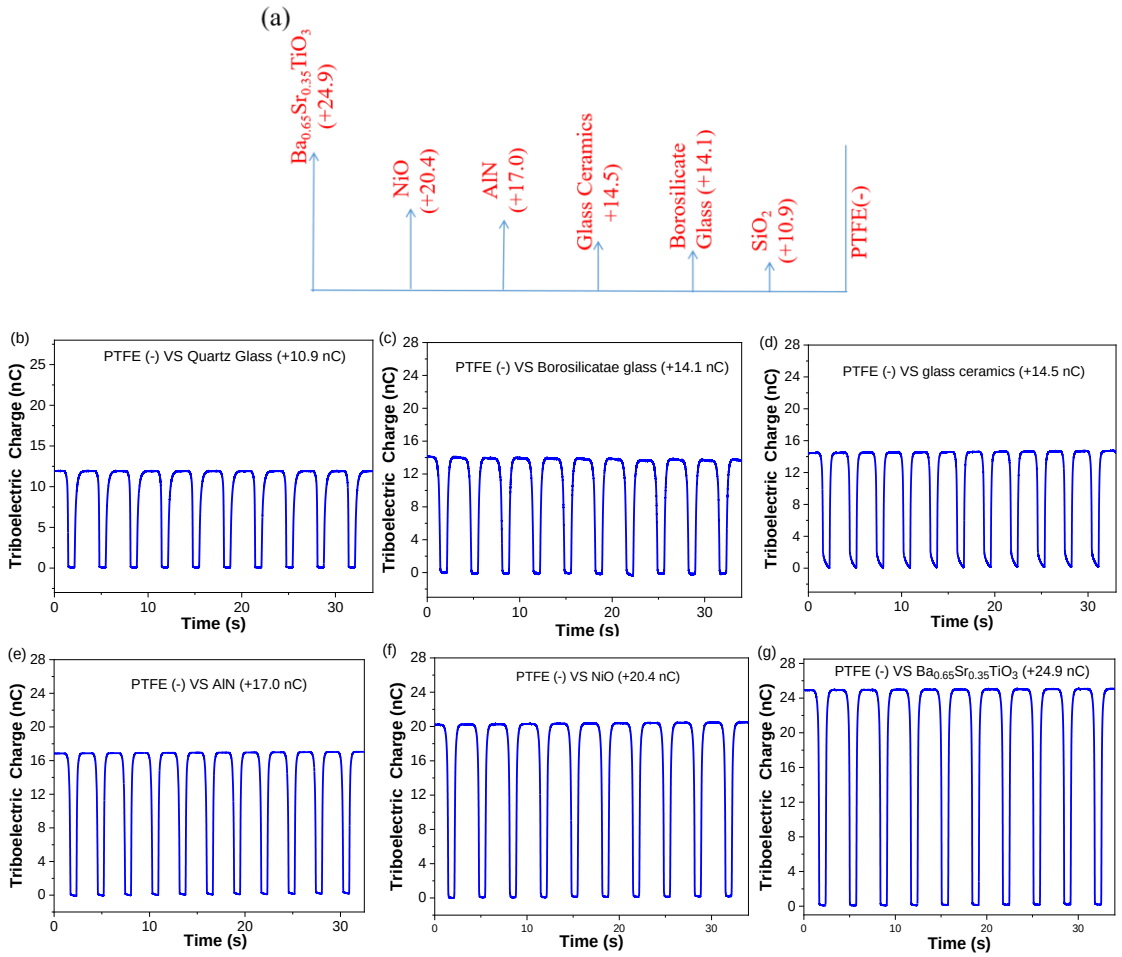
Supplementary Information for

Quantifying and understanding the triboelectric series of inorganic non-metallic materials

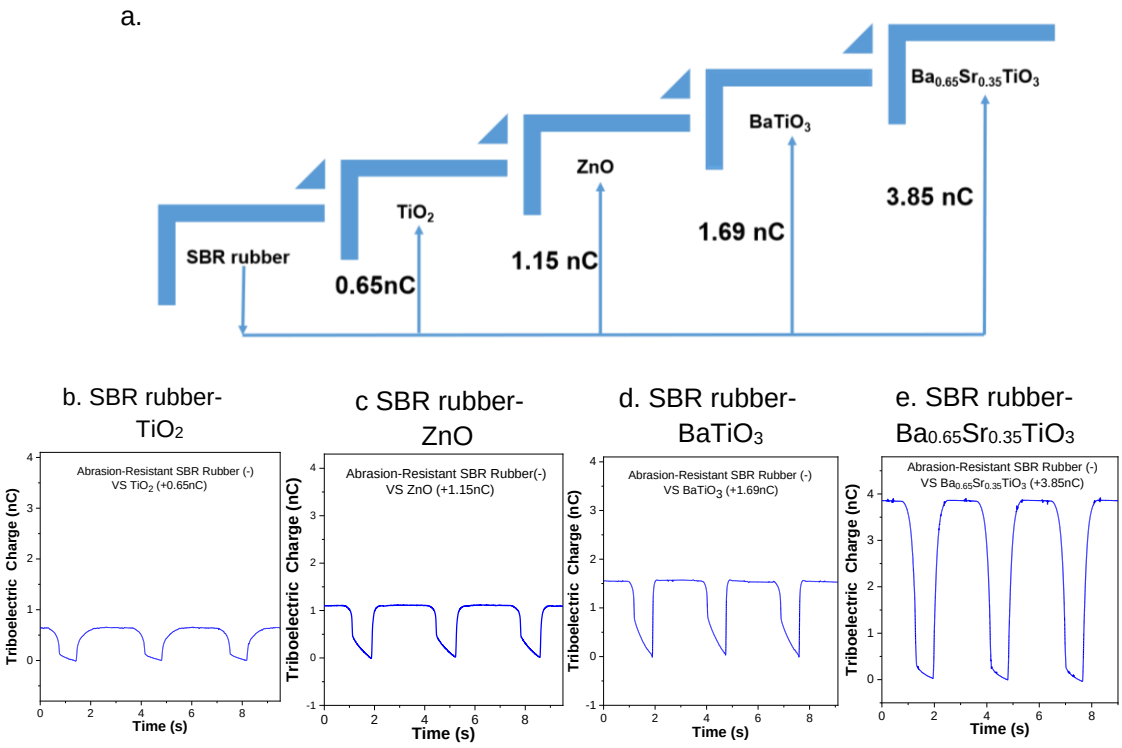
by Haiyang et al.



Supplementary Figure 1. The cross-check results charge transfer between various inorganic materials. (a) cross-check AlN with Glass ceramics and TiO_2, and (b) cross-check ZnO with $Ba_{0.65}Sr_{0.35}TiO_3$ and NiO.



Supplementary Figure 2. The charge transfer between PTFE and various inorganic materials. (a) The ranking for the tested materials in the triboelectric series. (b-g) The measured charge transfer between PTFE and Quartz Glass (b), Borosilicate glass (c), High-Temperature Glass Ceramic (d), AlN (e), NiO (f), and $Ba_{0.65}Sr_{0.35}TiO_3$ (g).



Supplementary Figure 3. The charge transfer between SBR rubber and various inorganic materials. (a) The ranking for the tested materials in the triboelectric series. (b-e) The measured charge transfer between SBR rubber and TiO_2 (b), ZnO (c), $BaTiO_3$ (d), and $Ba_{0.65}Sr_{0.35}TiO_3$ (e).

Supplementary Table 1. The details of tested materials. Note: mil is equal to one thousandth of an inch.

Materials	Vendor	Catalog No.	Synthesis Process	Thickness (mil)	Raw materials
Mica	Macmaster	8802K16			
Float glass	Beijing Kaifa Advanced Ceramics Technology Co., Ltd.			78.7	
Borosilicate glass	Macmaster	8476K12		125	
BeO	Guangzhou Beilong Electronics Co., Ltd.			27.6	
PZT-5	Zhejiang Gengjian Electronic Technology Co., Ltd.			78.7	
$MgSiO_3$	Synthesized		1、atmosphere：air 2、calcining temperature：1100℃ 3、calcining time：3h 4、sintering temperature：1400℃ 5、heating rate:3℃/min 6、sintering time：2h	63.3	MgO, SiO_2
$CaSiO_3$	Synthesized		1、atmosphere：air 2、calcining temperature：1100℃ 3、calcining time：3h 4、sintering temperature：1400℃ 5、heating rate:3℃/min 6、sintering time：2h	63.5	$CaCO_3$, SiO_2
$Bi_4Ti_3O_{12}$	Synthesized		1、atmosphere：air 2、calcining temperature：800℃ 3、calcining time：2h 4、sintering temperature：1200℃ 5、heating rate:3℃/min 6、sintering time：2h	61.9	Bi_2O_3,TiO_2
$Bi_{0.5}Na_{0.5}TiO_3$	Synthesized		1、atmosphere：air 2、calcining temperature：800℃ 3、calcining time：2h 4、sintering temperature：1160℃ 5、heating rate:3℃/min 6、sintering time：2h	62.4	Bi_2O_3,Na_2CO_3,TiO_2
$NiFe_2O_4$	Synthesized		1、atmosphere：air 2、calcining temperature：1100℃ 3、calcining time：6h 4、sintering temperature：1200℃ 5、heating rate:3℃/min 6、sintering time：6h	61.2	NiO,Fe_2O_3
$Ba_{0.65}Sr_{0.35}TiO_3$	Synthesized		1、atmosphere：air 2、calcining temperature：1100℃ 3、calcining time：3h 4、sintering temperature：1400℃ 5、heating rate:5℃/min 6、sintering time：3h	59.1	$BaCO_3$，$SrCO_3$,TiO_2

(To be continued)

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Materials	Vendor	Catalog No.	Synthesis Process	Thickness (mil)	Raw materials
$BaTiO_3$	Synthesized		1、atmosphere：air 2、calcining temperature：1100℃ 3、calcining time：3h 4、sintering temperature：1350℃ 5、heating rate:5℃/min 6、sintering time：3h	59.1	$BaCO_3$,TiO_2
PZT-4	Zhejiang Gengjian Electronic Technology Co., Ltd.			100.4	
ZnO	Synthesized		1、atmosphere：air 2、sintering temperature：1200℃ 3、heating rate:5℃/min 4、sintering time：1.5h	60.3	ZnO
NiO	Synthesized		1、atmosphere：air 2、sintering temperature：1420℃ 3、heating rate:5℃/min 4、sintering time：3h	59.1	NiO
SnO_2	Synthesized		1、atmosphere：air 2、sintering temperature：1300℃ 3、heating rate:5℃/min 4、sintering time：2h	59.3	SnO_2
SiC	Guangzhou Beilong Electronics Co., Ltd.			78.7	
$CaTiO_3$	Synthesized		1、atmosphere：air 2、calcining temperature：1100℃ 3、calcining time：3h 4、sintering temperature：1350℃ 5、heating rate:5℃/min 6、sintering time：3h	61.2	$CaCO_3$ TiO_2
ZrO_2	Guangzhou Beilong Electronics Co., Ltd.			39.4	
Cr_2O_3	Synthesized		1、atmosphere：air 2、sintering temperature：1500℃ 3、heating rate:5℃/min 4、sintering time：3h	60.2	Cr_2O_3
Fe_2O_3	Synthesized		1、atmosphere：air 2、sintering temperature：800℃ 3、heating rate:5℃/min 4、sintering time：3h	59.6	Fe_2O_3
Al_2O_3	Fujian Huaqing Electronic Material Technology Co.,Ltd.		1、atmosphere：air 2、sintering temperature：1600℃ 3、heating rate:5℃/min 4、sintering time：3h	39.4	
TiO_2	Synthesized		1、atmosphere：air 2、sintering temperature：1350℃ 3、heating rate:5℃/min 4、sintering time：3h	60.3	TiO_2

(To be continued)

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Materials	Vendor	Catalog No.	Synthesis Process	Thickness (mil)	Raw materials
AlN	Fujian Huaqing Electronic Material Technology Co.,Ltd.		1、atmosphere：N_2+H_2(5%) 2、sintering temperature：1800℃ 3、heating rate:5℃/min 4、sintering time：3h	39.4	
BN	Guangzhou Beilong Electronics Co., Ltd.			78.7	
Clear Very High-Temperature Glass Ceramic	Macmaster	84815K41		197	
Ultra-High-Temperature Quartz Glass	Macmaster	1357T47		62.5	

Supplementary Table 2. The work functions and dielectric constants of tested materials

Materials	Work function (eV)	Dielectric constant
Float glass		4.7[1]
Borosilicate glass		4.5 - 6.2[1]
BeO	3.95-4.7[2]	7.15-7.55[1]
PZT-5	4.5[3]	1600-3400[1]
$MgSiO_3$		6.5[1]
$CaSiO_3$	4.35-4.48[4]	5-5.65[1]
$Bi_4Ti_3O_{12}$		112[1]
$Bi_{0.5}Na_{0.5}TiO_3$		400[1]
$NiFe_2O_4$		17[5]
$Ba_{0.65}Sr_{0.35}TiO_3$	4.5[3]	3688[1]
$BaTiO_3$	4.0-4.8[6]	2300[1]
PZT-4	3.9-4.6[7]	1550[1]
ZnO	4.1-5.3[8]	8.2-11[1]
NiO	4.4- 5.2[9]	11.9[1]
SnO_2	4.7[10]	8.5-16[1]
SiC	4.41-4.85[11]	9.7-10.03[1]
$CaTiO_3$	5.30-5.35[12]	165[1]

(To be continued)

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Materials	Work function (eV)	Dielectric constant
ZrO_2	5.14[13]-5.55[14]	12.5[1]
Cr_2O_3	4.0[15]-4.8[16]	11.9-13.3[1]
Fe_2O_3	4.5-5.6[17]	12[1]
Al_2O_3	4.7-6[18]	9[1]
TiO_2	4.9-5.4[19]	86–170[1]
AlN	5.35[11]	8.7-9[1]
BN	B tip 5.843,N tip 7.203[20]	7.1[1]
Clear Very High-Temperature Glass Ceramic	—	—
Ultra-High-Temperature Quartz Glass	5.476-5.508[4]	4.41-4.6[1,4]
$CaTiO_3$	0.24	5.30-5.35[12]

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