Electronic Supplementary Material (ESI) for RSC Advances.

SUPPLEMENTARY INFORMATION

Simultaneous improvement in electrical conductivity and Seebeck coefficient of PEDOT: PSS by N_2 pressure-induced nitric acid treatment

May Thu Zar Myint[a], Masaki Hada[a], Hirotaka Inoue[a], Tatsuki Marui[a], Takeshi Nishikawa[a], Yuta Nishina[a], Susumu Ichimuya[b], Masayoshi Umeno [c], Aung Ko Ko Kyaw[d,e*] and Yasuhiko Hayashi[a*]

[a] *Graduate School of Natural Science and Technology, Okayama University, Okayama, 700-8530, Japan, Email: hayashi.yasuhiko@okayama-u.ac.jp*

[b] *Nagoya Industries Promotion Corporation, 3-4-41 Rokuban, Atsuta, Nagoya, 456-0058, Japan.*

[c] *C's Techno Inc., Anagahora, Shimoshidami, Moriyama, Nagoya, Aichi 463-0003, Japan.*

[d] *Department of Electrical and Electronic Engineering, Southern University of Science and Technology, Shenzhen 518055, P.R. China. Email: aung@sustc.edu.cn*

[e] *Shenzhen Planck Innovation Technologies Pte Ltd, Ganli, 6th Road, Longgang, Shenzhen, 518112 China.*

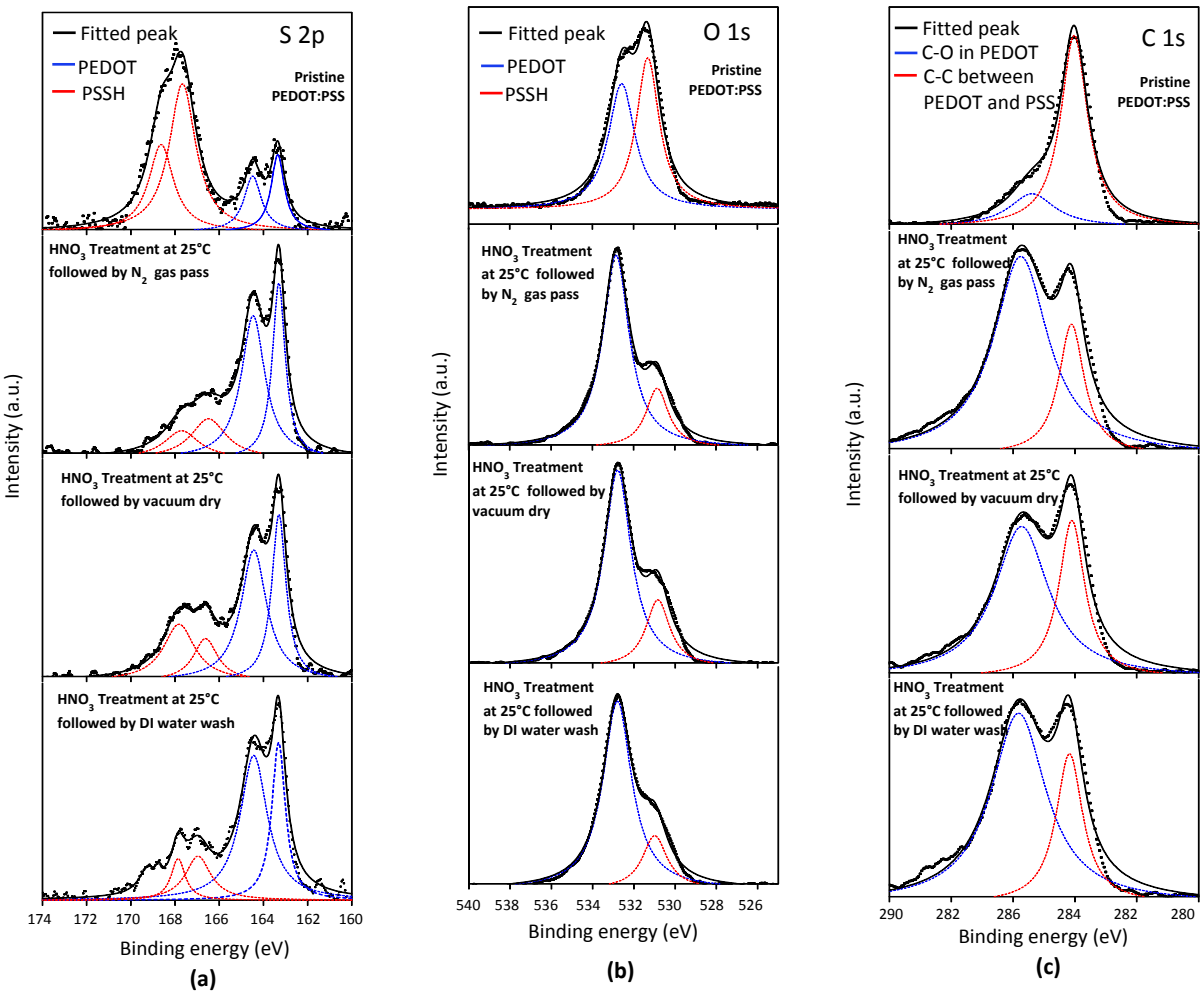

Figure S-1: (a) S 2p, (b) O 1s and (c) C 1s core-level spectra of the pristine PEDOT:PSS and HNO_3 treated PEDOT:PSS at different conditions. The dotted curves represent the experimental results and the blue and red curves correspond to the deconvoluted peaks for the PEDOT and PSSH.

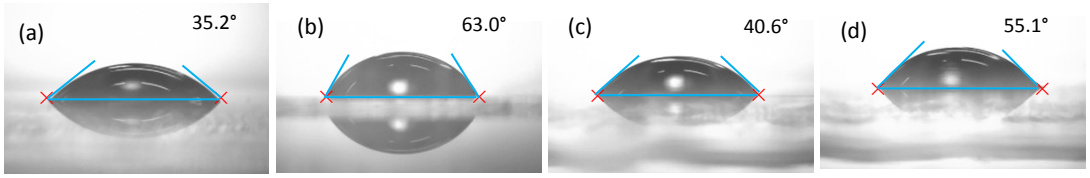

Figure S-2: Contact angle measurement of samples: (a) pristine PEDOT:PSS and treatment with HNO_3 followed by (b) N_2 gas passing, (c) vacuum dry, and (d) DI water wash. (Measurements were performed within 5s.)

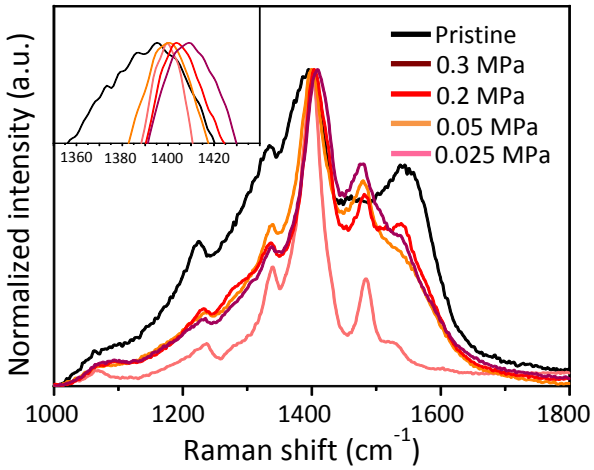

Figure S-3: Raman spectra of pristine PEDOT:PSS and that of the treated samples at pressures of 0.025 MPa, 0.05 Mpa, 0.2 MPa and 0.3 MPa, respectively. The inset curve shows the peak shift from 1396 cm^{-1} to 1399 cm^{-1}, 1400 cm^{-1}, 1404 cm^{-1} and 1409 cm^{-1} after the samples have treated with N_2 gas at pressures of of 0.025 MPa, 0.05 Mpa, 0.2 MPa and 0.3 MPa, respectively.

Table 1-Composition of the pristine PEDOT:PSS films and HNO_3 treated PEDOT:PSS films at different treatment conditions obtained by XPS analysis

photoelectron peaks	atom %			
	pristine PEDOT:PSS	Treatment with HNO_3 followed by N_2 gas passing	Treatment with HNO_3 followed by vacuum dry	Treatment with HNO_3 followed by DI water wash
S $2p_{3/2}$	5.88	6.25	6.27	6.33
S $2p_{1/2}$	16.13	18.33	17.88	19.08
O 1s	24.54	24.15	24.25	23.63
C 1s	51.01	51.26	51.31	50.18

Table 2-Interplanar spacing and grain size of the PEDOT:PSS films at various 2θ values before and after treatment .

Treatment condition		2θ (degree)	d-spacing (nm)	grain size (nm)
pristine	(100)	–	–	–
Treatment with HNO_3 at 25°C followed by N_2 gas passing		6.9°	1.28	5.04
Treatment with HNO_3 at 25°C followed by vacuum dry		6.9°	1.28	4.7
Treatment with HNO_3 at 25°C followed by DI water wash		6.6°	1.34	3.6
Treatment with HNO_3 at 130°C followed by DI water wash		–	–	–
pristine	(200)	–	–	–
Treatment with HNO_3 at 25°C followed by N_2 gas passing		13.2°	0.67	5.07
Treatment with HNO_3 at 25°C followed by vacuum dry		13°	0.68	4.71
Treatment with HNO_3 at 25°C followed by DI water wash		12°	0.74	3.62
Treatment with HNO_3 at 130°C followed by DI water wash		–	–	–
pristine	amorphous halo diffraction	17.5°	0.51	0.87
Treatment with HNO_3 at 25°C followed by N_2 gas passing		–	–	–
Treatment with HNO_3 at 25°C followed by vacuum dry		18.3°	0.48	4.74
Treatment with HNO_3 at 25°C followed by DI water wash		18.7°	0.47	3.65
Treatment with HNO_3 at 130°C followed by DI water wash		–	–	–
pristine	(010)	25.6°	0.35	0.91
Treatment with HNO_3 at 25°C followed by N_2 gas passing		–	–	–
Treatment with HNO_3 at 25°C followed by vacuum dry		25.9°	0.34	4.8
Treatment with HNO_3 at 25°C followed by DI water wash		–	–	–
Treatment with HNO_3 at 130°C followed by DI water wash		–	–	–

Table 3-Contact angles of the PEDOT:PSS films before and after HNO_3 treatment at various conditions.

Time	Contact angle (°)			
	Pristine	Treatment with HNO_3 at 25°C followed by N_2 gas passing	Treatment with HNO_3 at 25°C followed by vacuum dry	Treatment with HNO_3 at 25°C followed by DI water wash
5 s	35.2	63	40.6	55.1
15 s	33.5	63.4	40.4	54.7
25 s	22.0	62.3	39.4	53.4
65 s	18.5	60.5	38.4	51.9