Supporting Information

Highly machine-washable e-textiles with high strain sensitivity and high thermal conduction

Zhenhua Tang[a,b], Dijie Yao[b], Donghe Du[a], and Jianyong Ouyang[a,*]

[a] Department of Materials Science & Engineering, National University of Singapore, Singapore 117576. Email address: mseoj@nus.edu.sg

[b] School of Physics and Optoelectric Engineering, Guangdong University of Technology, Guangzhou Higher Education Mega Center, Guangzhou, 510006, China

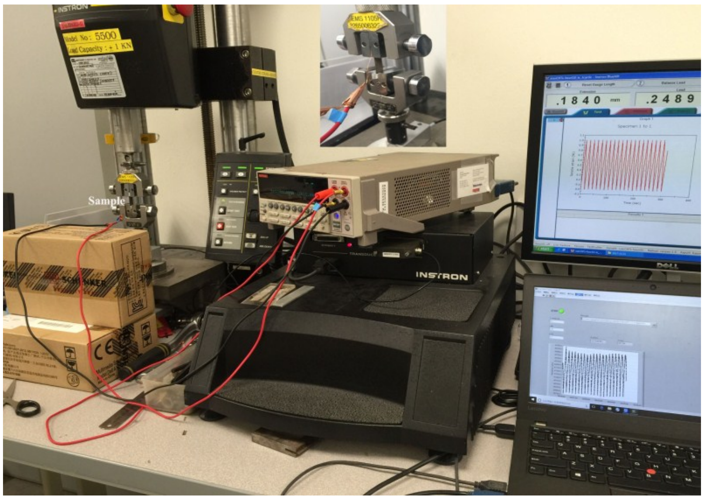

Fig. S1 Setup for the cyclic mechanical and electrical tests.

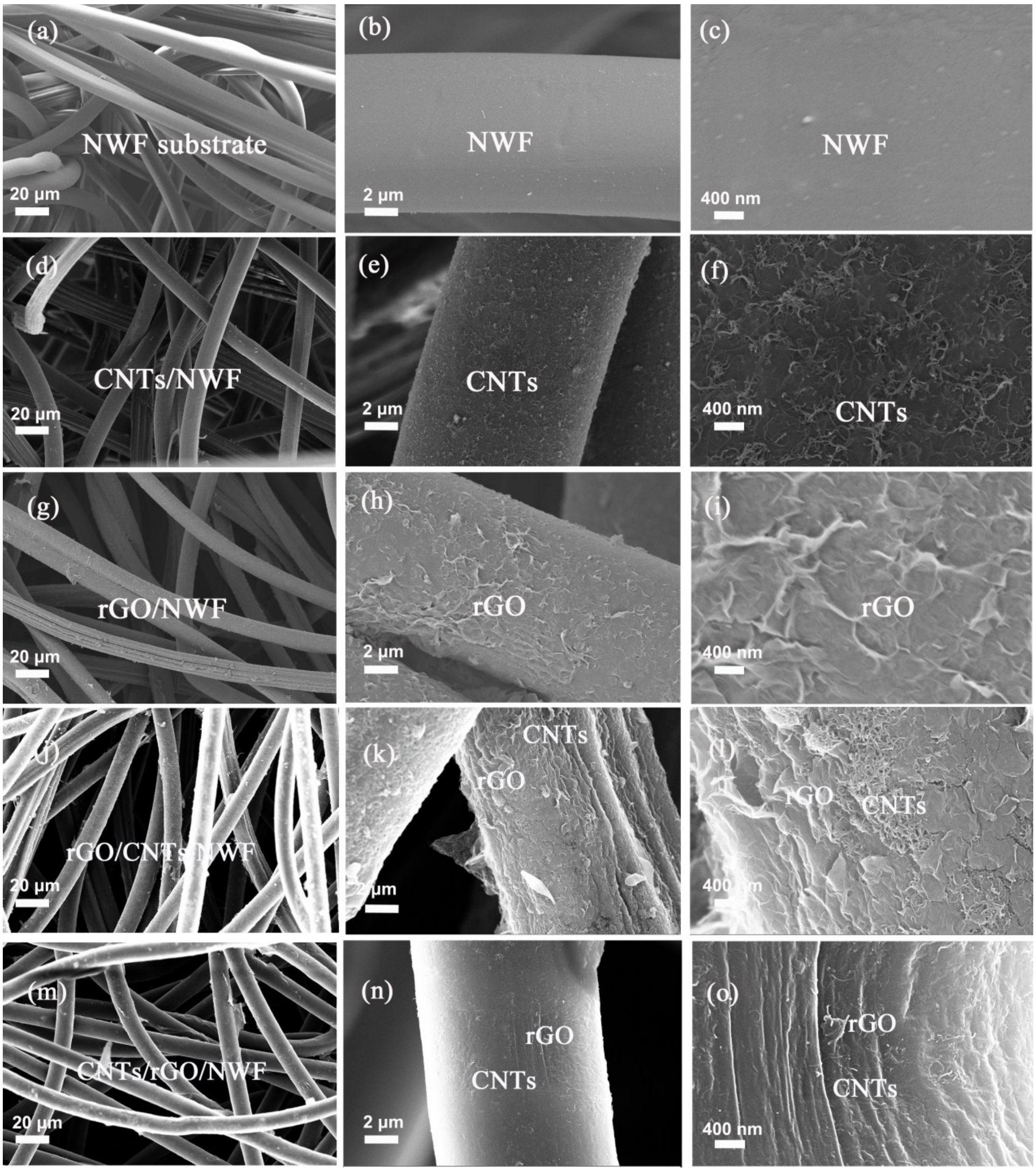

Fig. S2 SEM images of (a-c) NWF, (d-f) CNTs/NWF, (g-i) rGO/NWF, (f-l) rGO/CNTs/NWF and (m-o) CNTs/rGO/NWF with different magnifications.

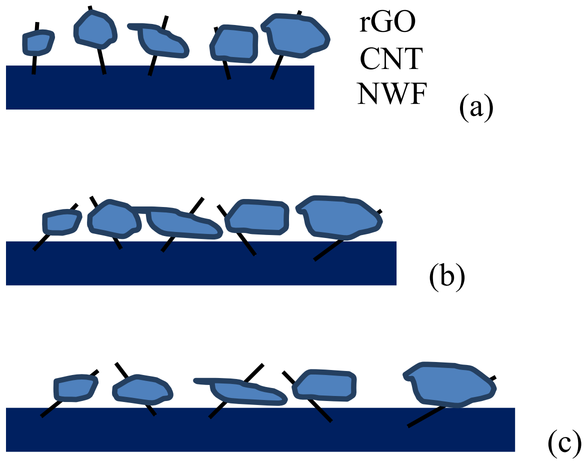

Fig. S3 Schematic illustration of the strain sensing behavior of the rGO/CNTs/NWF e-textiles under different tensile strains: (a) 0 %, (b) <10.4%, (c) > 10.4 %.

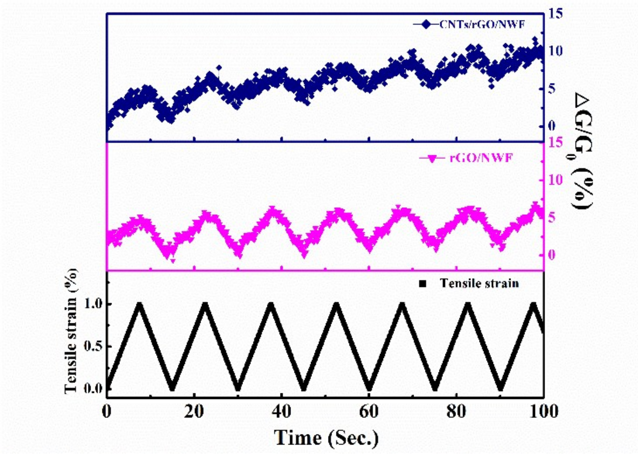

Fig. S4 $\Delta G/G_0$ of the rGO/NWF and CNTs/rGO/NWF sensors during cyclic tensile with the maximum strain of 1.0%.

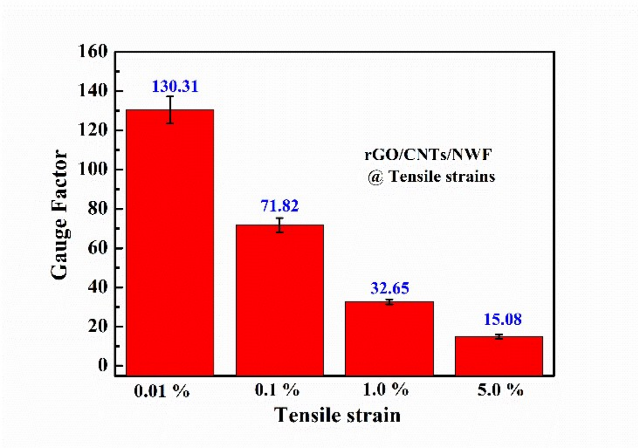

Fig. S5 The corresponding gauge factors for the rGO/CNTs /NWF sensor under the different tensile strains

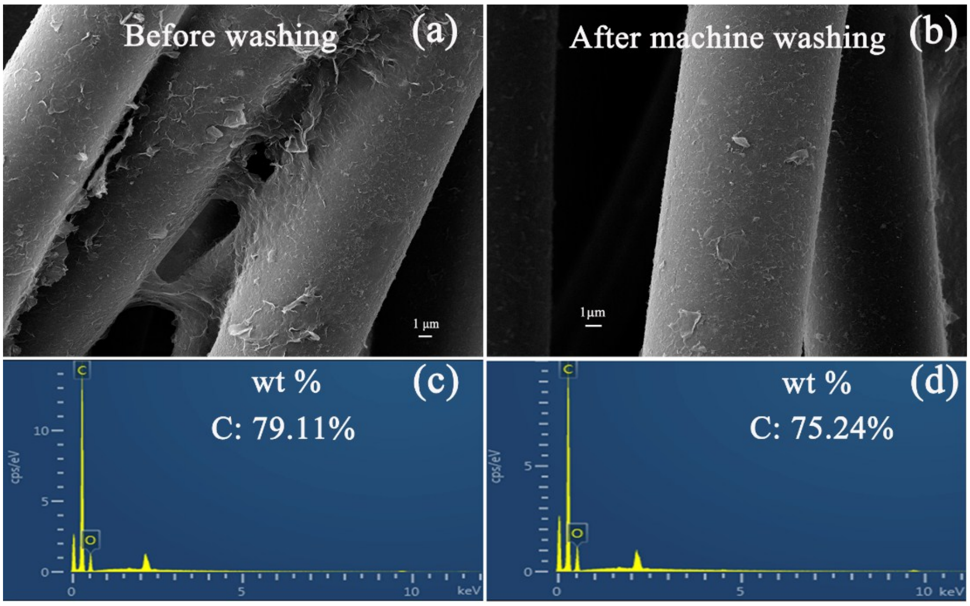

Fig. S6 The SEM and EDS results before and after six machine washing cycles with detergent.

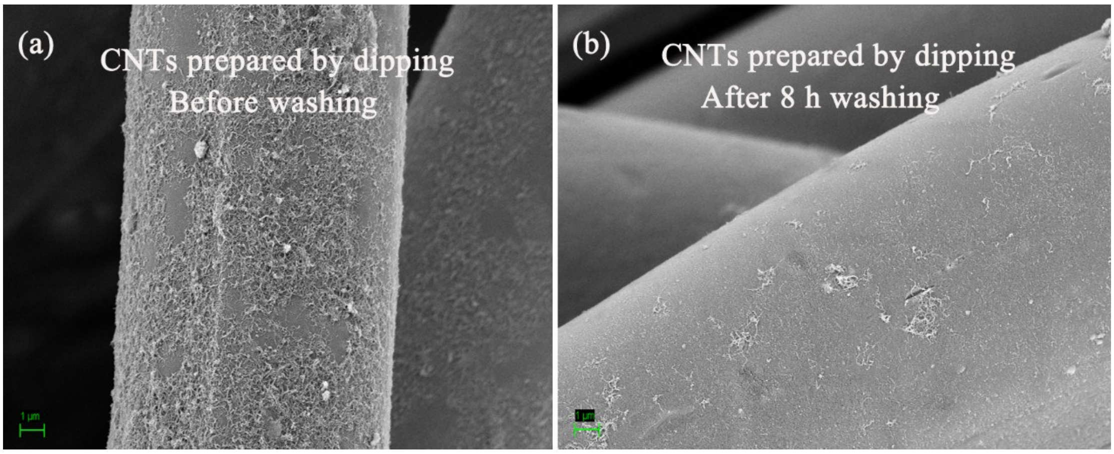

Fig. S7 SEM images of the CNTs/NWF prepared by dipping casting: (a) before and (b) after mechanical washing in water for 8 hours.

Movie S1 The rGO/CNTs/NWF sensor as a wearable sensor on a forefinger to monitor the finger movement in DI water.

Table S1 Comparison of rGO/CNTs/NWF textile strain sensors' properties to others in literature.

Materials and structure	Method	Gauge factor	Thermal conductivity ($Wm^{-1}K^{-1}$)	Strain Range (%)	Subtle strain limitation (%)	Repeat-ability	Wash-ability	Ref.
rGO/CNTs/NWF	**Nano-soldering followed by in situ reduction**	**130.31**	**2.9**	**0.01-7.9**	**0.01**	**More than 3000 cycles**	**More than 48 hours**	**This work**
rGO/NWF	**Diping casting**	**7.1**	–	–	**1.0**	–	–	**[1]**
CNTs/NWF	**Nano-soldering**	**29.9**	–	**1.0-7.9**	**1.0**	**1000 cycles**	**40 hours**	**[2]**
SACNT/PDMS	**Coating**	**100**	–	**4.0-400**	**0.01**	**5000 cycles**	–	**[3]**
Ag-NW/PDMS	**Vacuum filtration and transfer**	**~20**	–	**0.5-35**	**0.5**	**1000 cycles**	–	**[4]**
3D-GF/PDMS	**Facile and scalable method**	**98.66**	–	**5.0-30**	**5.0**	**200 cycles**	–	**[5]**
SWCNTs/cotton/PU yarn	**Coating**	**2-20**	–	**5.0-100**	**5.0**	**270 k cycles**	–	**[6]**
Carbonized Cotton Fabric	**Carbonization**	**64**	–	**0.02-80**	**0.02**	**2000 cycles**	–	**[7]**
GE/AgNPs/TPU	**Immersion-swelling followed by in situ reduction**	**476**	–	**0.5-500**	**0.5**	**1000 cycles**	–	**[8]**
Cotton	–	–	**0.0047**	–	–	–	–	**[9]**
Textile fibres	–	–	**0.000054**	–	–	–	–	**[10]**
Carbon fibre textile reinforcements	–	–	**0.302**	–	–	–	–	**[11]**
3D printable hBN nanocomposite	**3D printing techniques**	–	**2.1**	**175**	–	–	–	**[12]**
Polyethylene/carbon fiber composites	–	–	**0.47**	–	–	–	–	**[13]**
PA/OBC/EG composites	–	–	**2.63**	–	–	–	–	**[14]**

References

[1] D. Du, P. Li and J. Ouyang, J. Mater. Chem. C, 2016, 4, 3224-3230.

[2] D. Du, Z. H. Tang and J. Ouyang, J. Mater. Chem. C, 2018, 6, 883.

[3] Y. Yu, Y. Luo, A. Guo, L. Yan, Y. Wu, K. Jiang, Q. Li, S. Fan and J. Wang, Nanoscale, 2017, 9, 6716.

[4] K. K. Kim, S. Hong, H. M. Cho, J. Lee, Y. D. Suh, J. Ham, and S. H. Ko, Nano Lett., 2015, 15, 5240.

[5] J. Li, S. Zhao, X. Zeng, W. Huang, Z. Gong, G. Zhang, R. Sun, and C.-P. Wong, ACS Appl. Mater. Interfaces, 2016, 8, 18954.

[6] Z. Wang, Y. Huang, J. Sun, Y. Huang, H. Hu, R. Jiang, W. Gai, G. Li, and C. Zhi, ACS Appl. Mater. Interfaces, 2016, 8, 24837.

[7] M. Zhang, C. Wang, H. Wang, M. Jian, X. Hao, and Y. Zhang, Adv. Funct. Mater., 2017, 27, 1604795

[8] S. Chen, Y. Wei, X. Yuan, Y. Lin and L. Liu, J. Mater. Chem. C, 2016, 4, 4304.

[9] N. Oğlakcioğlu, A. Marmarali, Fibres & Textiles in Eastern Europe, 2007, 15, 64.

[10] S. Baxter, Proc. Phys. Soc., 1946, 58, 105.

[11] Y. Ei-Hage, S. Hind, and F. Robitaille, Journal of Textiles and Fibrous Materials, 2018, 1, 1.

[12] L. M. Guiney, N. D. Mansukhani, A. E. Jakus, S. G. Wallace, R. N. Shah, and M. C. Hersam, Nano Lett., 2018, 18, 3488.

[13] X. Huang, G. Alva, L. Liu, G. Fang, Applied Energy, 2017, 200, 19.

[14] W. Wu, W. Wu, S. Wang, Applied Energy, 2019, 236,10.