

Supplementary Information for

Charge trapping with α -Fe₂O₃ nanoparticles accompanied by human hair towards an enriched triboelectric series and a sustainable circular bioeconomy

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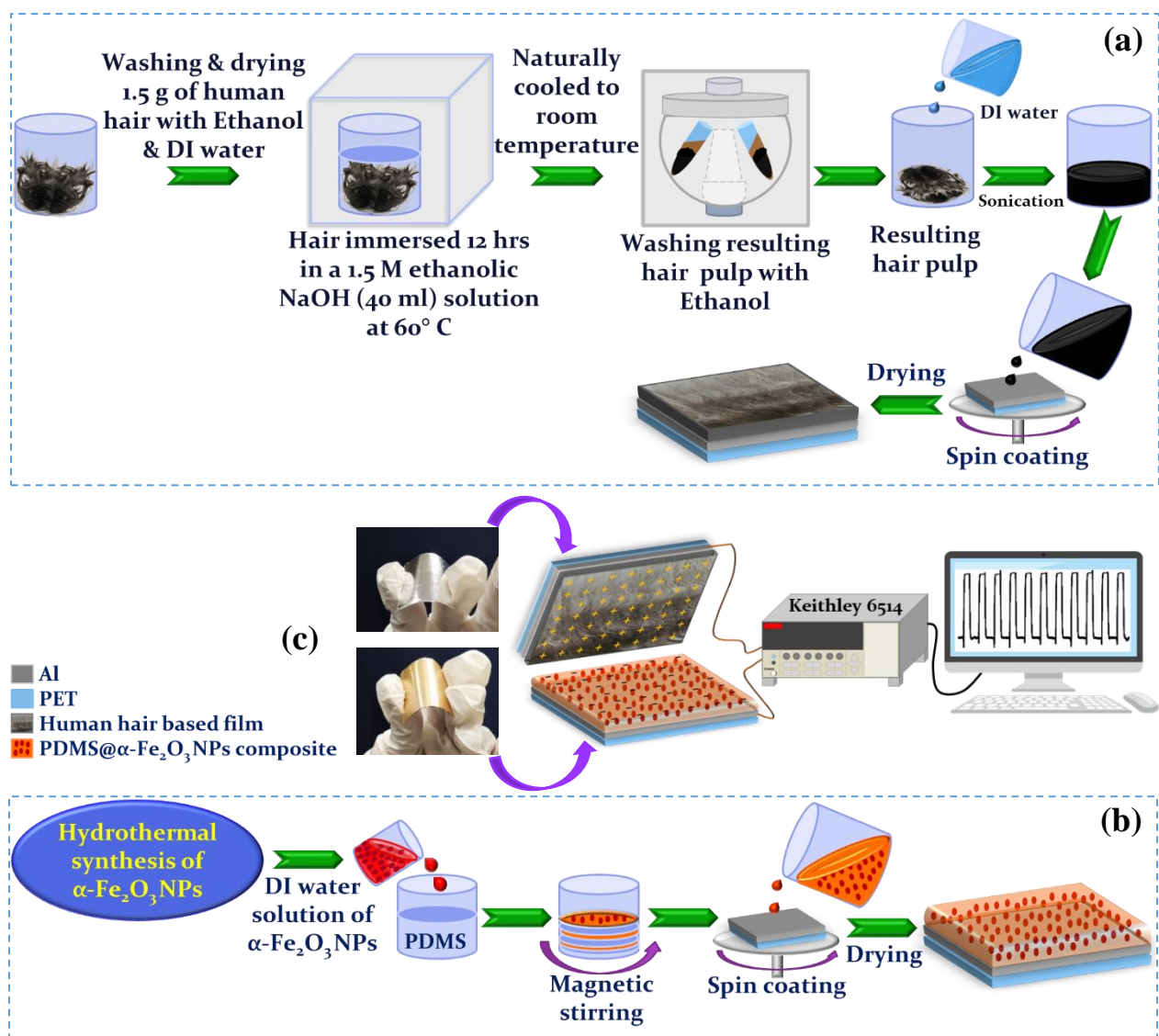


Fig S1. Schematic diagram of the process for fabricating (a) the human hair-based film over PET/Al as positive side of TENG and (b) the PDMS@ α -Fe₂O₃ NP film over PET/Al as the negative side of TENG, (c) Schematic description for the TENG based on the PDMS@ α -Fe₂O₃ NP composite film and human hair-based film along with the respective photographs.

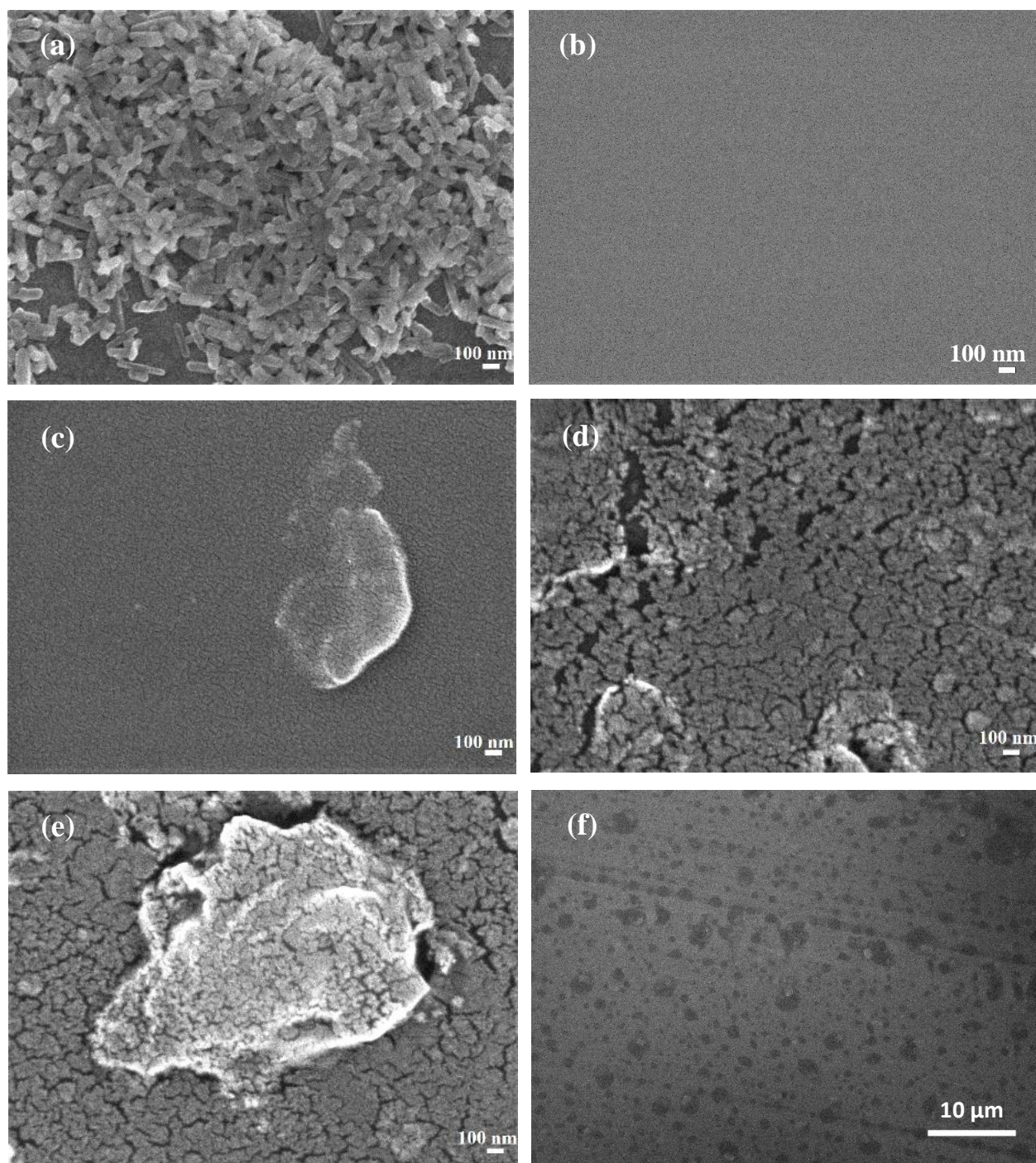


Fig S2. FESEM images of the (a) α -Fe₂O₃ NPs and PDMS@ α -Fe₂O₃ NP composite with (b) 0, (c) 0.036, (d) 0.077, (e) 0.09 wt.% α -Fe₂O₃ NPs contents. (f) FESEM image of human hair-based film.

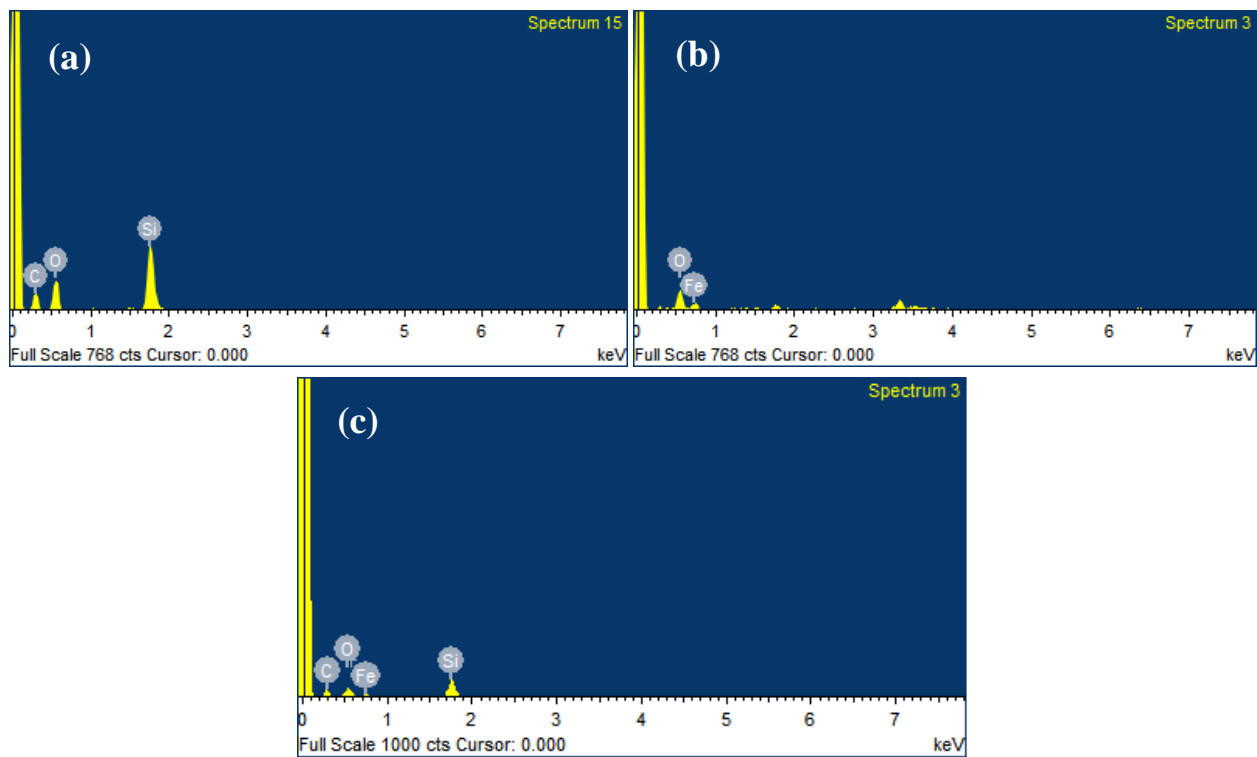


Fig S3. EDS spectra of the (a) PDMS film (b) α -Fe₂O₃ NPs and (c) PF₂ film.

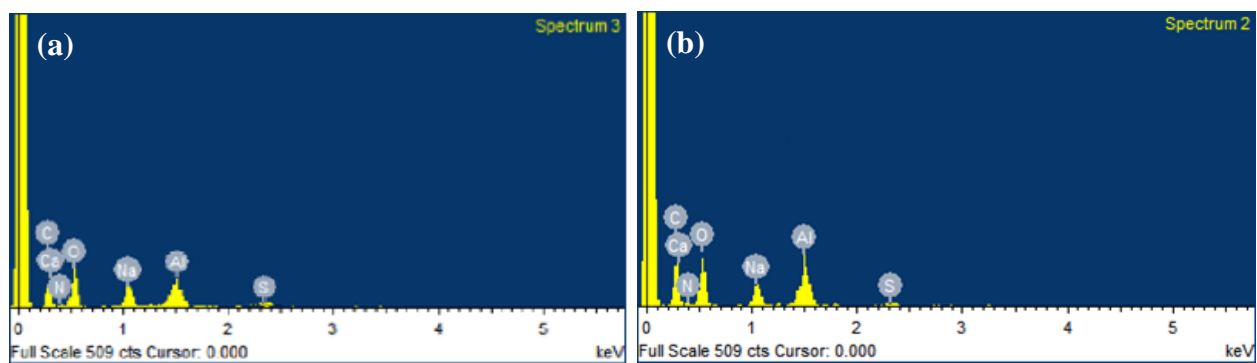


Fig S4. EDS spectra of the (c) dark shaded region, (d) light shaded region in FESEM images of human hair-based film.

$R_q = 8.89 \text{ nm}$, $R_a = 6.91 \text{ nm}$

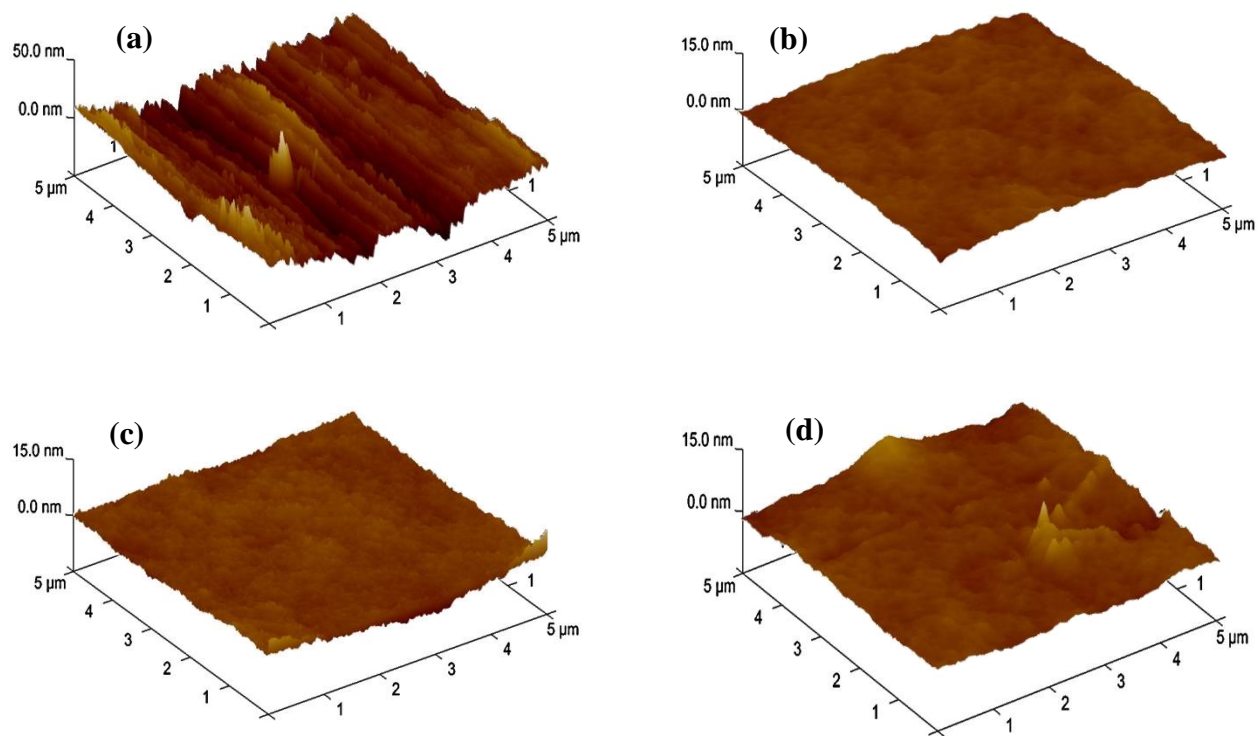


Fig S5. AFM images (three-dimensional) of (a) Al film and PDMS@ $\alpha\text{-Fe}_2\text{O}_3$ NP composite with (b) 0.036, (c) 0.077, (d) 0.09 wt.% $\alpha\text{-Fe}_2\text{O}_3$ NPs content.

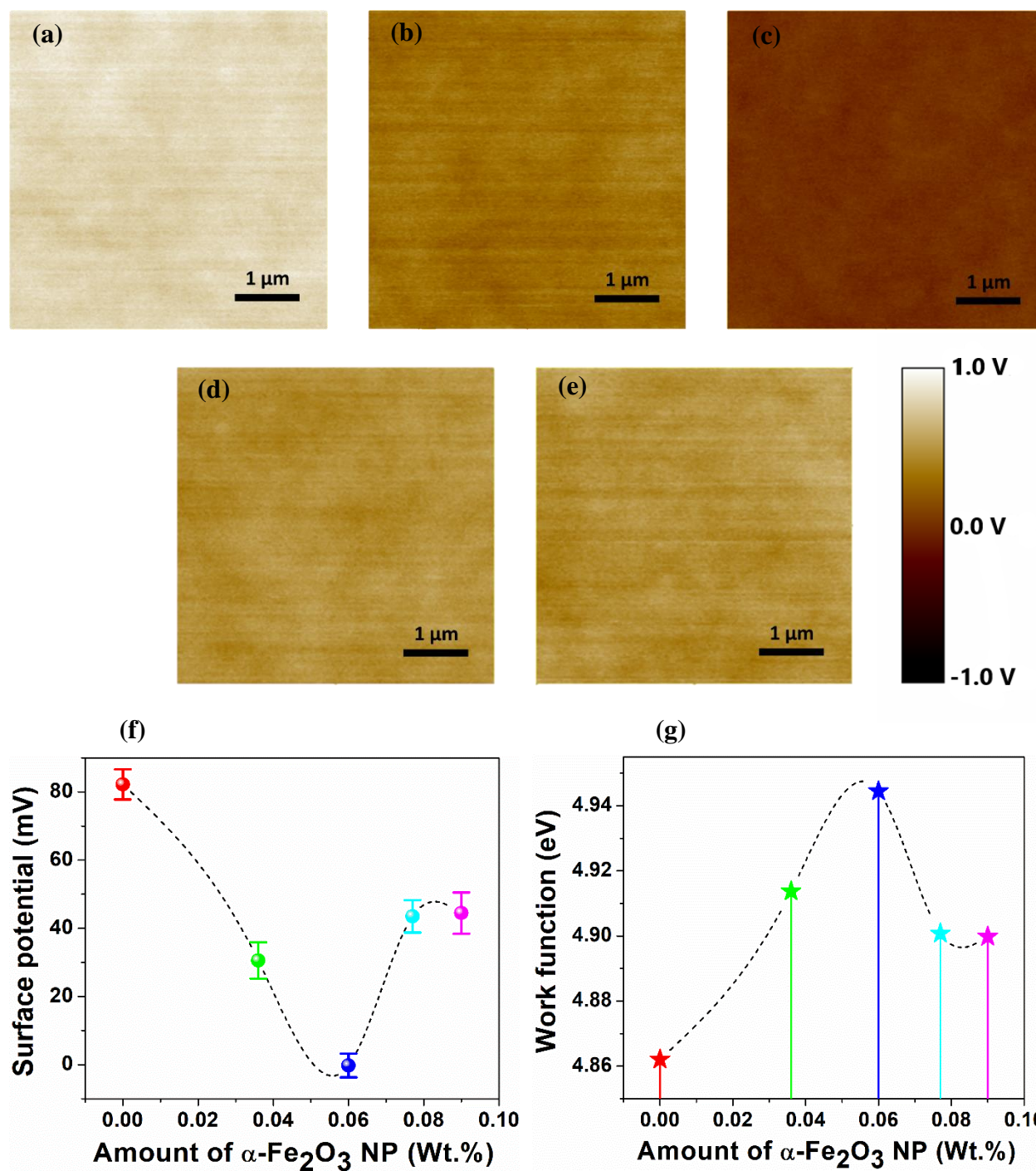


Fig S6. Surface potentials of the PDMS@ α -Fe₂O₃ NP composite with (a) 0, (b) 0.036, (c) 0.06 (d) 0.077, (e) 0.09 wt.% α -Fe₂O₃ NPs content. (f) The mean value of surface potential with standard deviation and (g) corresponding work function variation due to the insertion of α -Fe₂O₃ NPs into PDMS matrix.

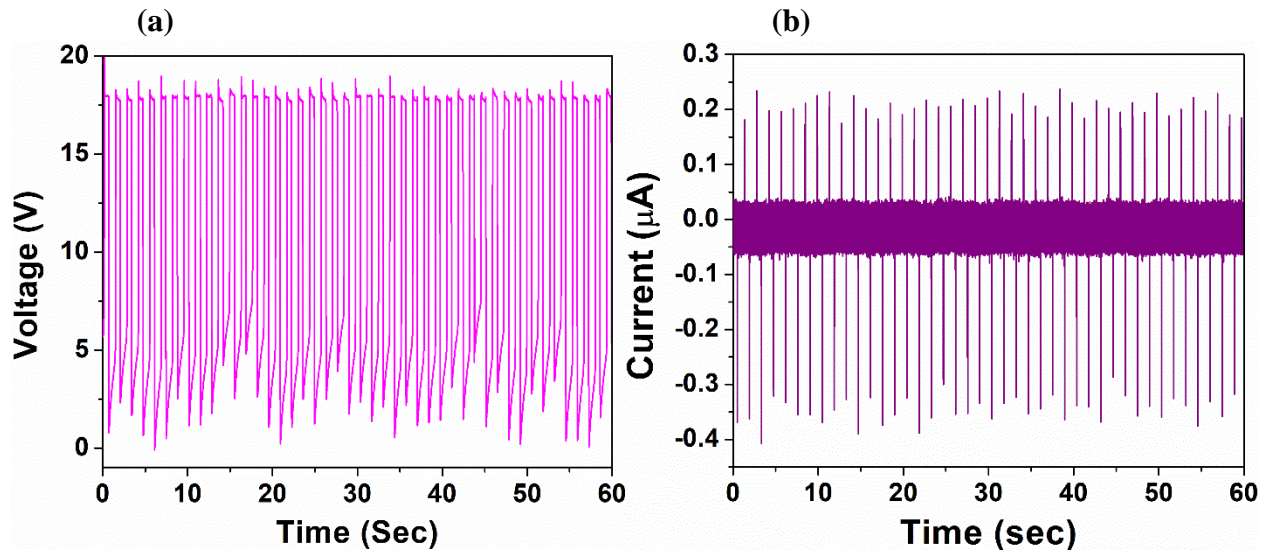


Fig S7. (a) Voltage and (b) Current outputs of TENGs with PDMS (as negative electrification layers) and Al film (as the positive electrification layer).

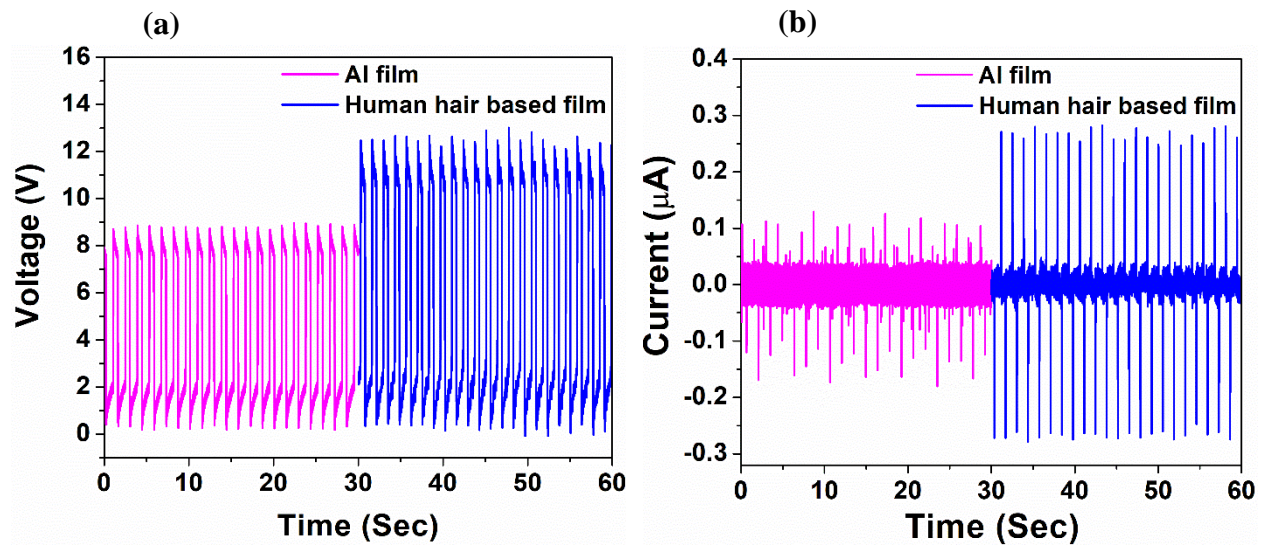


Fig S8. (a) Voltage and (b) Current outputs of TENGs based on α -Fe₂O₃ NPs (as negative electrification layers) with Al film and human hair-based film separately (both as the positive electrification layer).

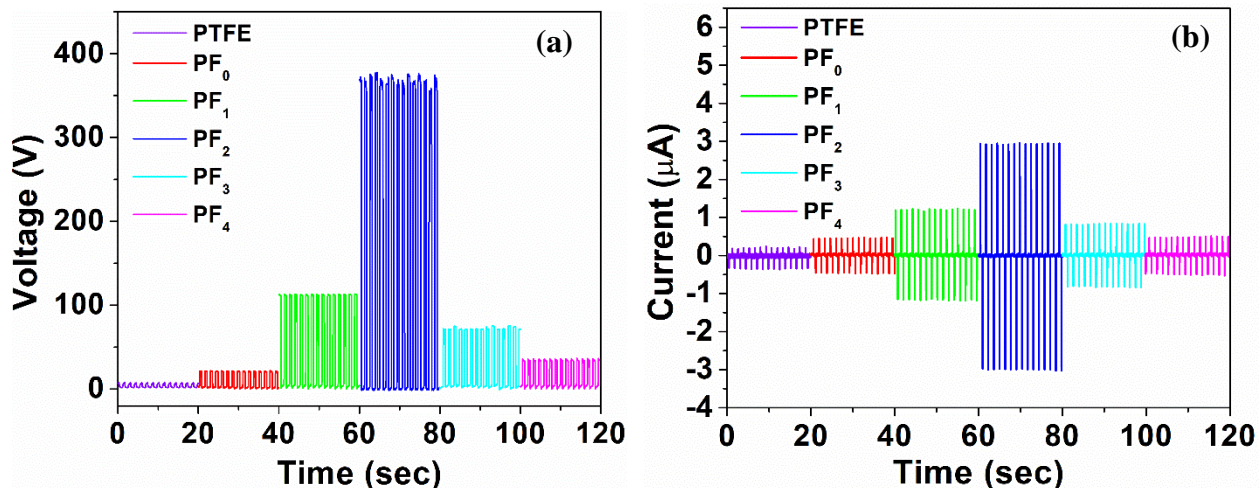


Fig S9. (a) Voltage and (b) Current outputs of TENGs with PTFE and PDMS@ α -Fe₂O₃ NP film as negative electrification layers accompanied by human hair-based film (as the positive electrification layer).

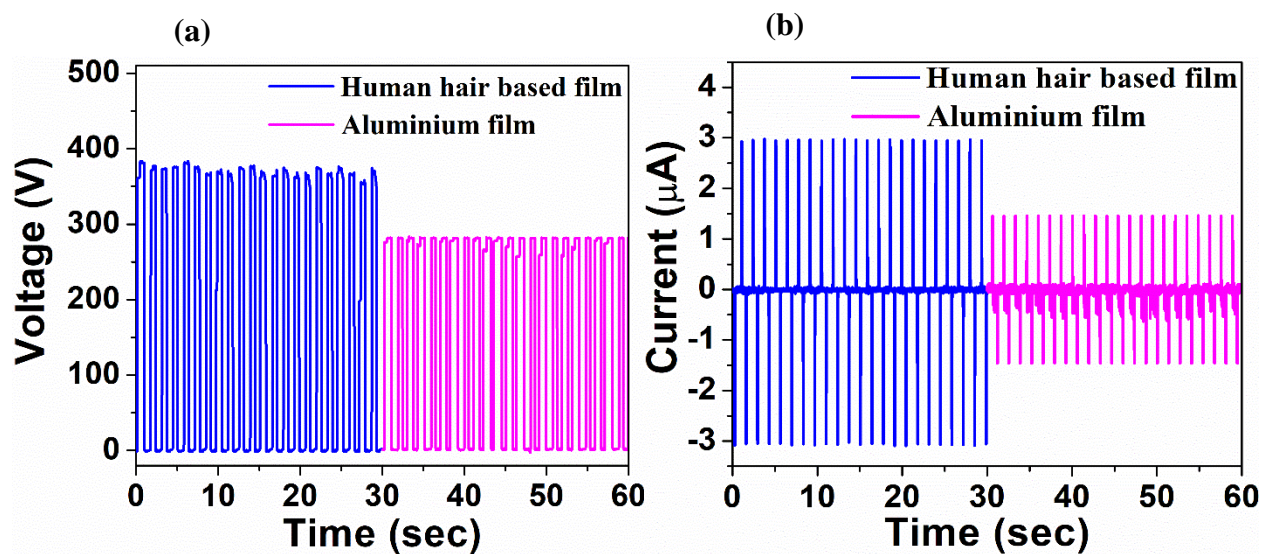


Fig S10. (a) Voltage and (b) Current outputs of PF₂ based TENGs with human hair and Al as positive electrification layers separately.

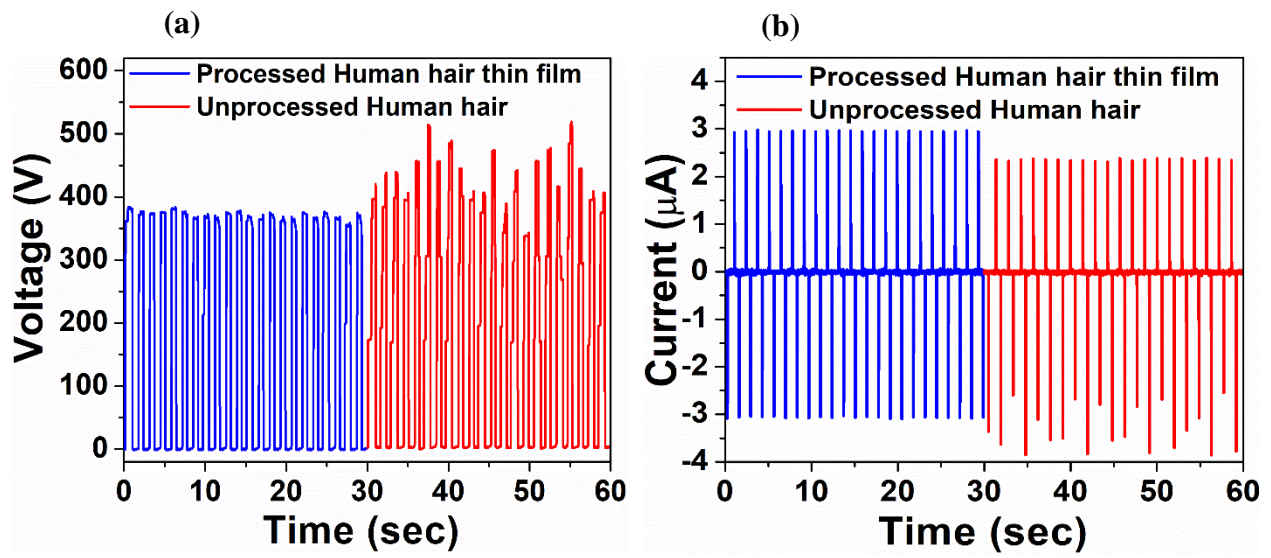


Fig S11. (a) Voltage and (b) Current outputs of PF₂ based TENGs with treated and untreated human hair as positive electrification layers separately.

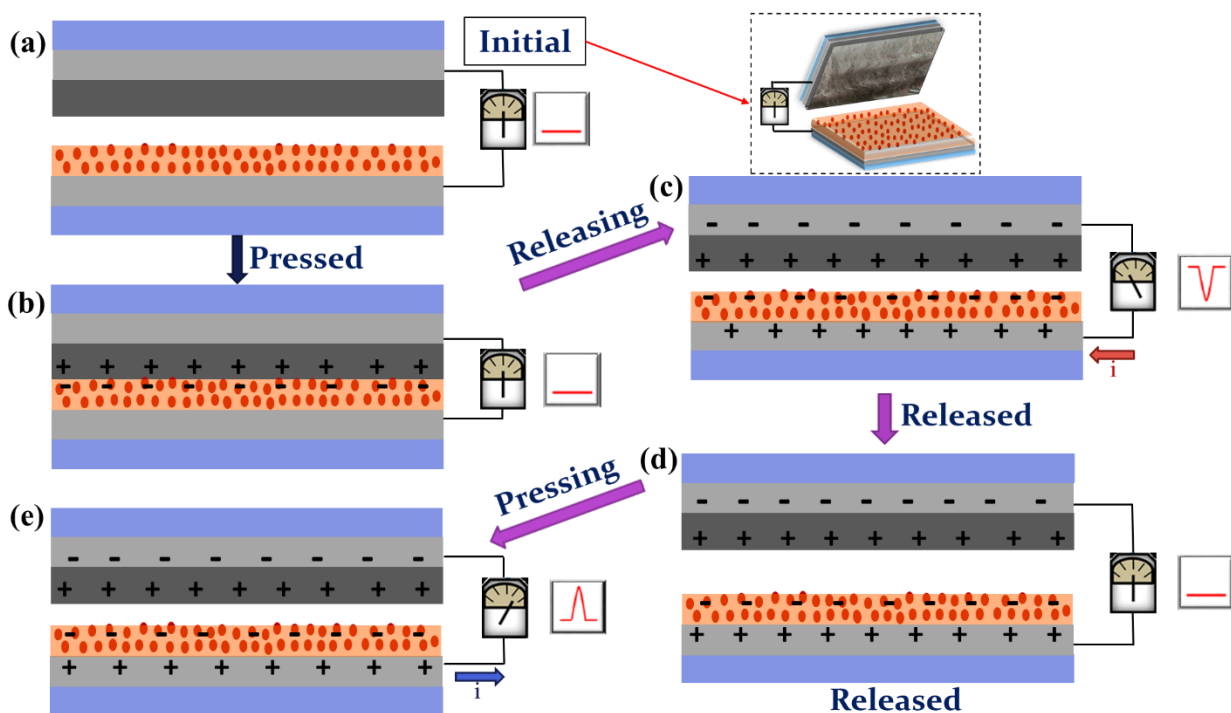


Fig S12. Working mechanism of PDMS@ α -Fe₂O₃ NP film (as the negative electrification layer) and human hair (as the positive electrification layer) based TENG, (a) Initial state of the TENG (b) The first contact, no output signal appears (c) On succeeding releasing, a negative output electric signal is initiated (d) After two layers get completely released, the output drops to zero (e) On subsequent pressing, a positive electric signal is generated.

Roughness (nm)	PF₀	PF₁	PF₂	PF₃	PF₄
rms roughness, Rq	0.444	0.510	0.543	0.609	0.880
average roughness, Ra	0.353	0.405	0.434	0.479	0.626

Table S1. Morphology Data of PDMS film and PDMS@ α -Fe₂O₃ NP composite films.