ADVANCED FUNCTIONAL MATERIALS

Supporting Information

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Chemically Functionalized Natural Cellulose Materials for Effective Triboelectric Nanogenerator Development

Chunhua Yao, Xin Yin, Yanhao Yu, Zhiyong Cai, and Xudong Wang**

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Chemically-Functionalized Natural Cellulose Materials for Effective Triboelectric Nanogenerator Development

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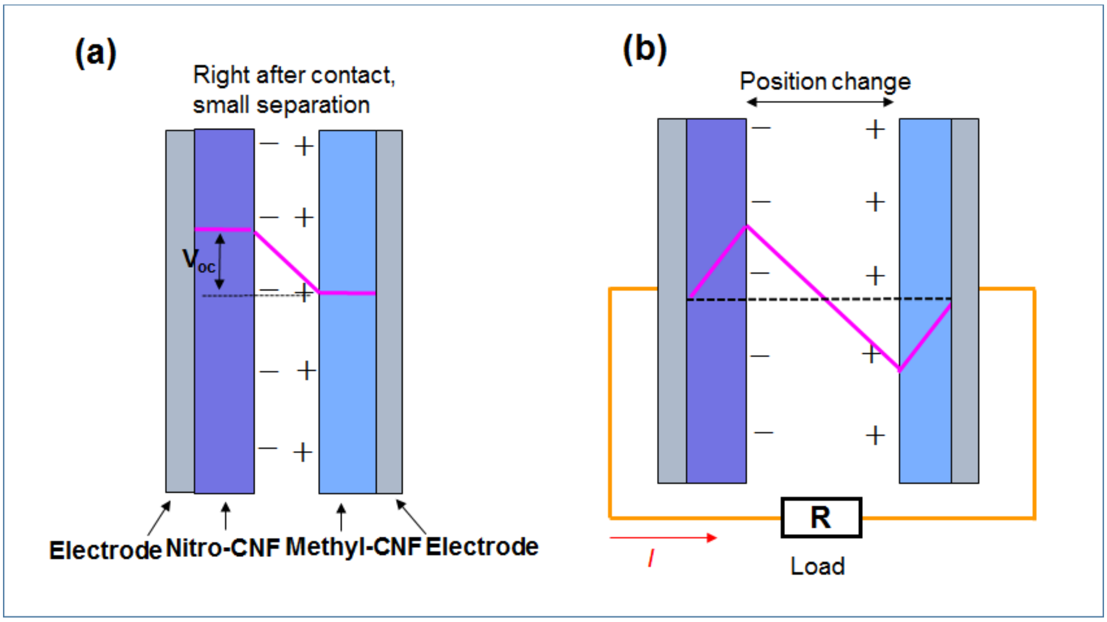

Figure S1. Schematic mechanism of TENG when nitro-CNF and methyl-CNF films were used. **(a)** Right after these two films are separated, negative charges were generated on the nitro-CNF surface, and positive charges are generated on the methyl-CNF surface. The different charges on the two film surfaces create an electrical potential difference at the interface, which is indicated by the solid slanting line between the two films. This potential difference is considered as the open circuit voltage (V_{oc}) of the TENG. **(b)** The potential difference can induce static charge on the back electrode based on the dielectric property of the CNF films and balance the electrical energy. As the space between the two CNF film changes, the capacitance changes accordingly and the system is no longer in equilibrium. When an external circuit is connected between the two back electrodes, the potential difference can drive charge flow through the load *R*, *i.e.* the output current. When *R*=0, the current is regarded as the short-circuit current (I_{sc}). Constantly changing the separation generates oscillating current flow through the external load, known as the triboelectric output.

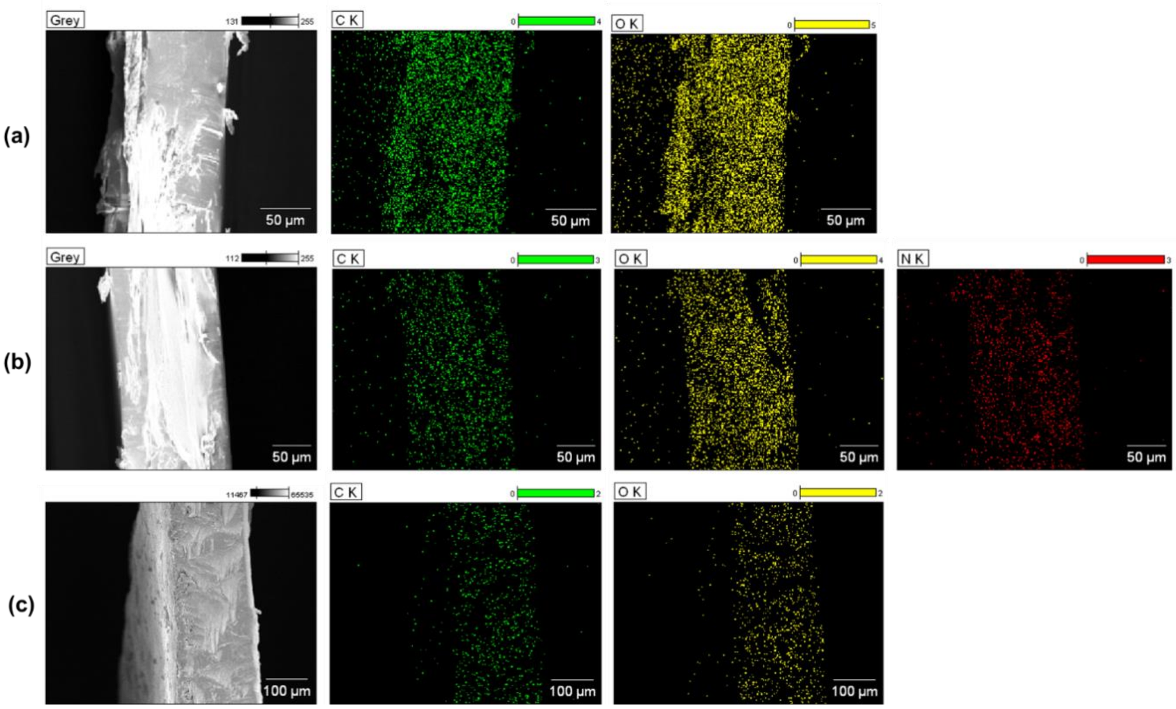

Figure S2. SEM and EDX scanning on the cross section of CNF films, showing the homogeneity of the chemical modification. **(a)** pristine CNF, **(b)** nitro-CNF, **(c)** methyl-CNF.

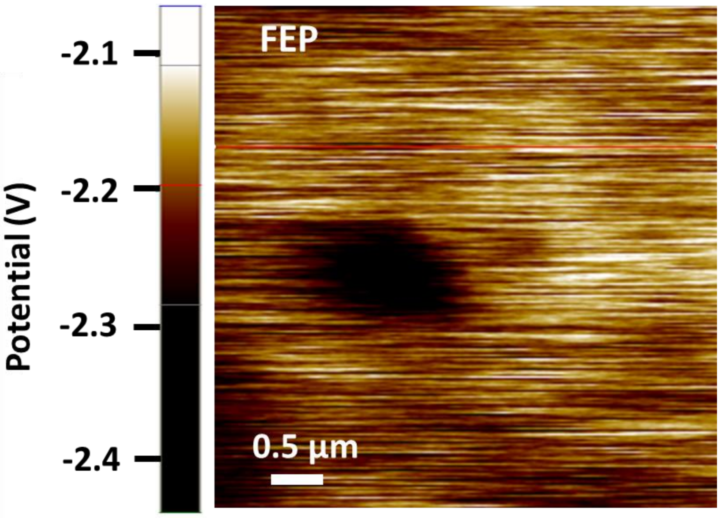

Figure S3. SKPM surface potential mapping of FEP surface.

Specifically, the surface potential of the targeting film was determined by detecting an applied external bias that nullifies the electrical force between the sample and the AFM tip caused by the different Fermi energy levels. With this principle, the surface potentials and the topography of the modified CNF films were obtained simultaneously when scanning with a conductive AFM tip, indicating a correlation between the surface potential and the surface topography. This is because the surface roughness could alter the local electrostatic potential and the transfer of free electrons, thus influencing the surface potentials. Such a linear relationship between the surface potential and the surface roughness has been reported in the metal Mg and Al systems.[1] Therefore, the non-uniform surface potential in CNF films could be attributed to the rough surface. However, despite the variation of the surface potential, the average value over the scanned area still evaluates the surface potential of the samples.

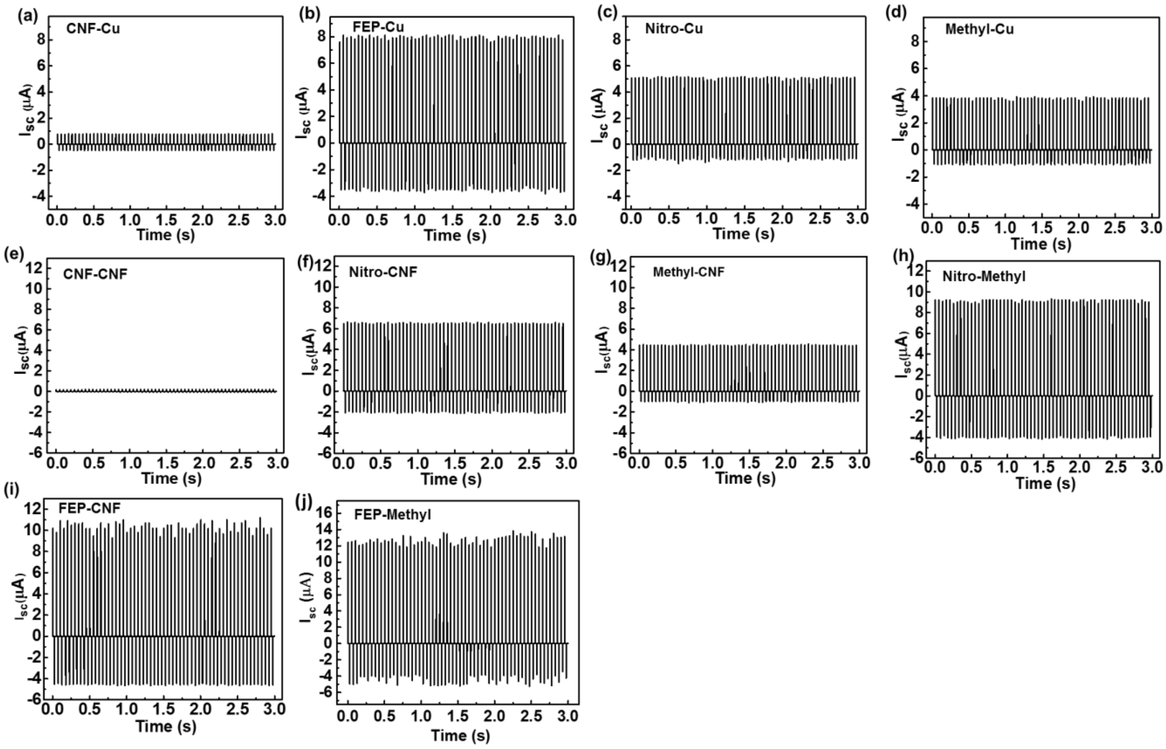

Figure S4. Current output of TENGs made from various film pairs of **(a)** CNF/Cu, **(b)** FEP/Cu, **(c)** nitro-CNF/Cu, **(d)** methyl-CNF/Cu, **(e)** CNF/CNF, **(f)** nitro-CNF/CNF, **(g)** methyl-CNF/CNF, **(h)** nitro-CNF/methyl-CNF, **(i)** FEP/CNF, and (j) FEP/methyl-CNF.

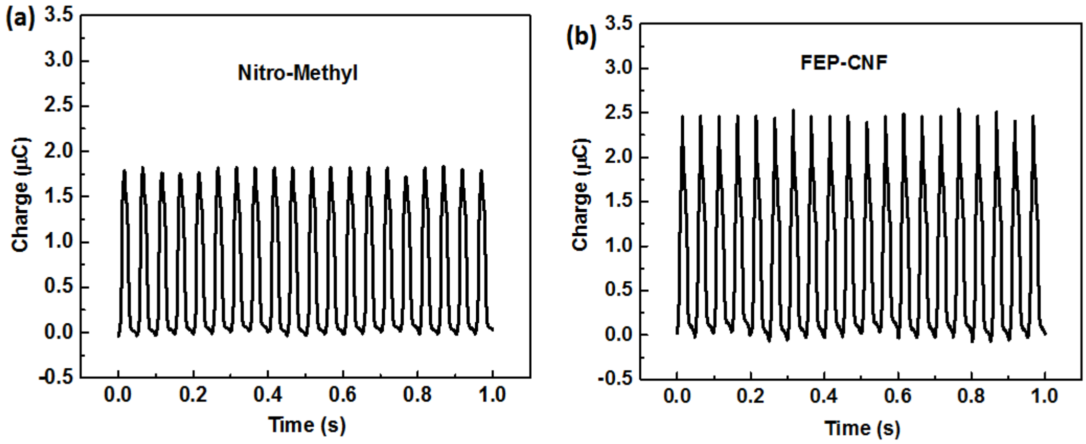

Figure S5. Shor-circuit charge transfer measured from TENGs made from nitro-CNF/methyl-CNF film pair (a) and FEP/CNF film pair (b).