Supporting information for

Oxidative Damage during the Operation of Si(211)-Based Triboelectric Nanogenerators

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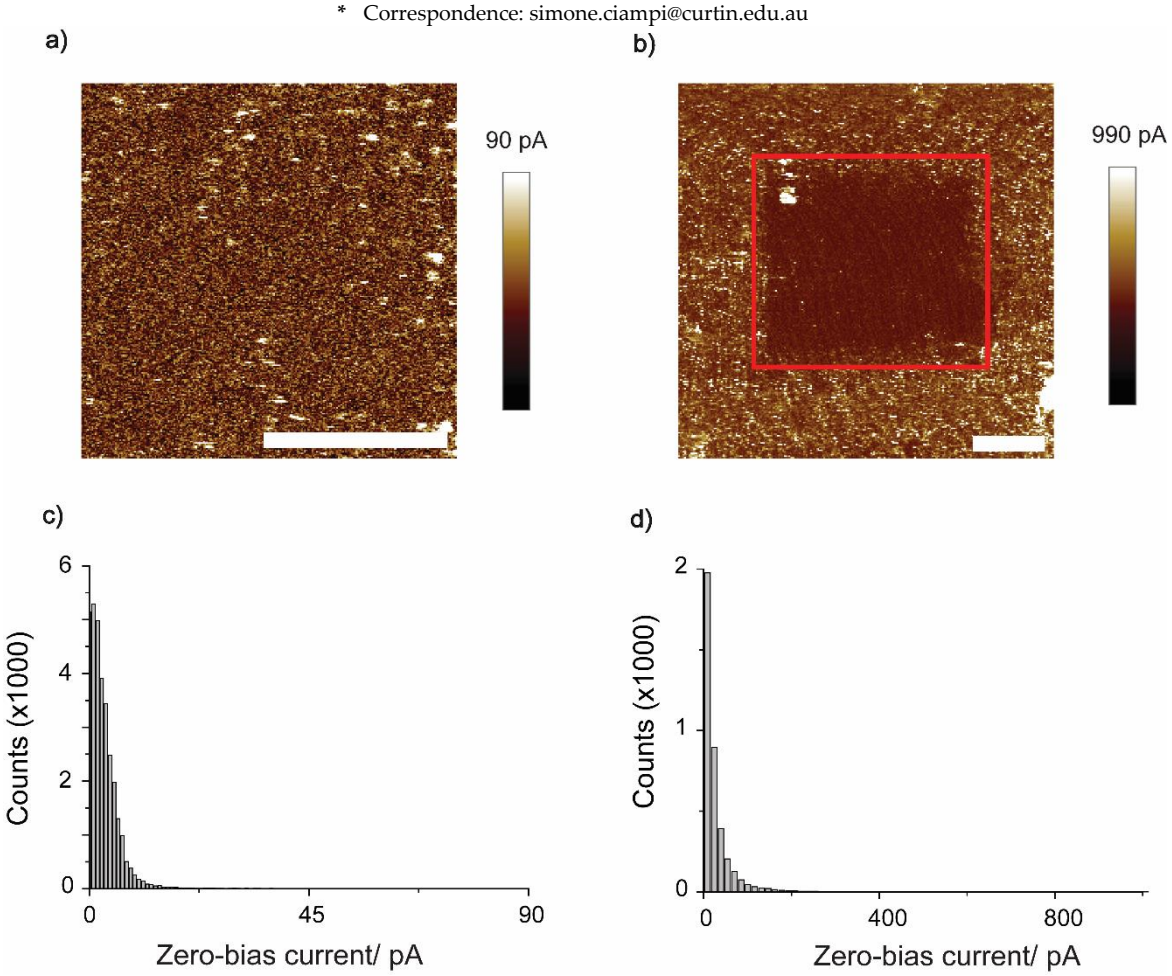

Figure S1. (a, b) Sequential C-AFM images (2 × 2 μm (a), 5 × 5 μm (b)) recorded at zero-voltage bias on a Si(211) **S-1** sample. The first map (2 × 2 μm (a)) was recorded setting a normal force set point of 50 nN. The corresponding histogram plot for the current output is shown in panel (c). The second map (5 × 5 μm (b)) covered the sample area imaged in (a) and was acquired under a normal force of 360 nN. The specific area highlighted by a red square coincides with the region scanned in panel (a). The current histogram associated with the region marked by the red square within this broader C-AFM map is depicted in panel (d). It is important to note that the histogram counts represent the quantity of pixels (sample locations) falling within each current value/bin. The complete C-AFM map (5 × 5 μm) comprises a total of approximately 65,000 pixels. Horizontal scale bars indicating 1 μm are provided in panels (a) and (b).

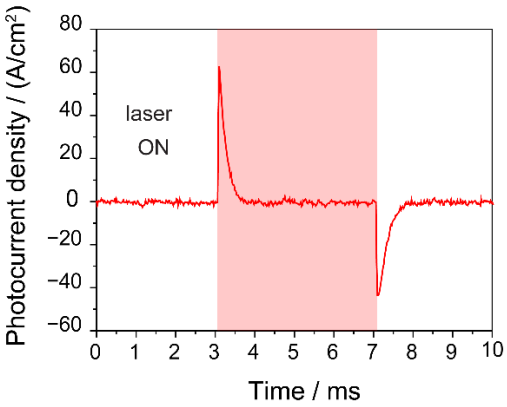

Figure S2. Example of a "capacitor-like" PCM transient trace.

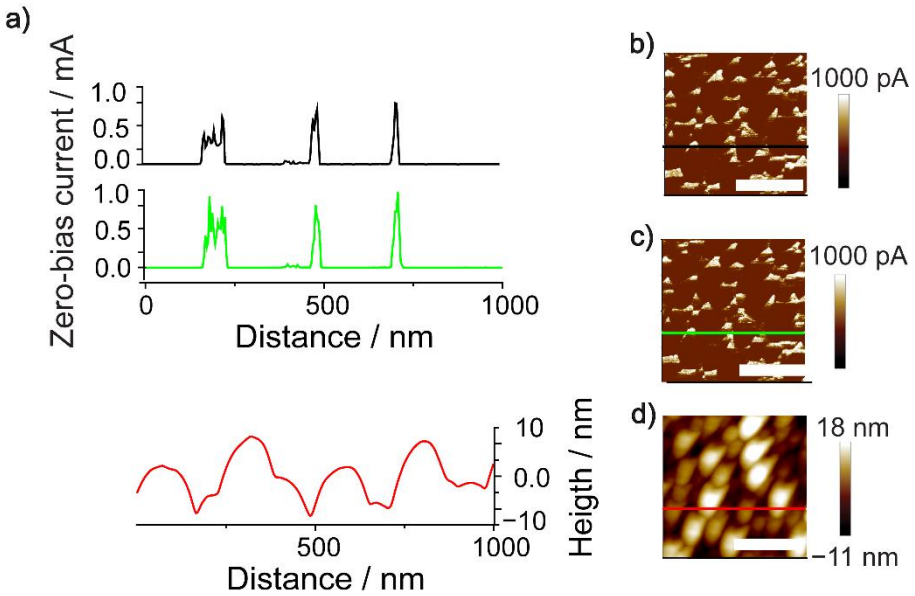

Figure S3. (a) Zero-bias DC current and topography profiles obtained during C-AFM experiments. The green and black color coding indicates the direction of the scan: first a trace (green, left to right) and then a retrace (black, right to left) over the same line. The topographic (height) profile is indicated by the red trace. (c–e) C-AFM and topography maps indicating the location of the line along which the current trace (green), current retrace (black) and topography (red) data of panel (a) were acquired.

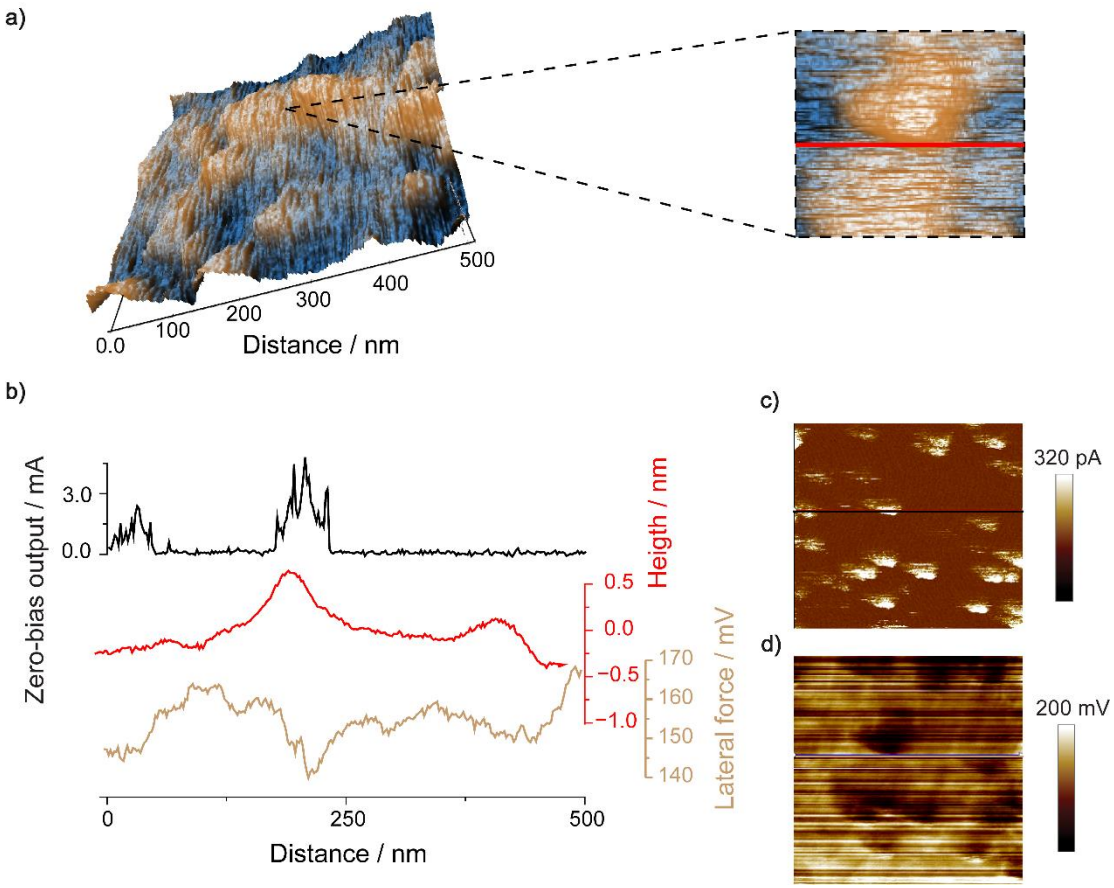

Figure S4. (a) 3D topography scan image of a Si(211) **S-1** surface. (b) Zero-bias DC current, topography and lateral force profiles obtained during C-AFM experiments. The black color indicate the current profile output (trace direction). The height profile is indicated by the red trace. The brown color profile represents the lateral force data. (c) Zero-bias current map. (d) Lateral force (tip deflection) map.

Contact area (Pt AFM tip–S1 sample) determination

The DMT (Derjaguin–Muller–Toporov) model is a widely used approach for studying solid adhesion in materials, particularly applicable to hard and weakly adhesive substances such as silicon. The model's equation for estimating the contact area (A) is expressed as follows:

$$A = \pi \left\{ \frac{R}{K} (L + 2\pi R\gamma) \right\}^{\frac{2}{3}}$$

Here:

R refers to the tip radius,

K represents the reduced Young's modulus,

L is the normal applied force, and$2\pi R\gamma$ denotes the adhesion force.

The adhesion force is determined by averaging data from multiple F–D (force–distance) curves. Meanwhile, the reduced Young's modulus (K) can be calculated using the formula:

$$\frac{1}{K} = \frac{4}{3} \left(\frac{1 - \nu_1^2}{E_1} + \frac{1 - \nu_2^2}{E_2} \right)$$

where E represents the Young's modulus and ν represents the Poisson ratio. For silicon and platinum, the Poisson ratios are 0.222 and 0.395, respectively, with Young's modulus values of 162.9 GPa and 177.3 GPa, respectively. Thus, the reduced Young's modulus for these materials is determined to be 70.78 GPa. Experimental contact area have been observed to be 80 nm² on average.