Large-Scale Efficient Water Harvesting using Bioinspired Micro-Patterned Copper Oxide Nanoneedle Surfaces and Guided Droplet Transport

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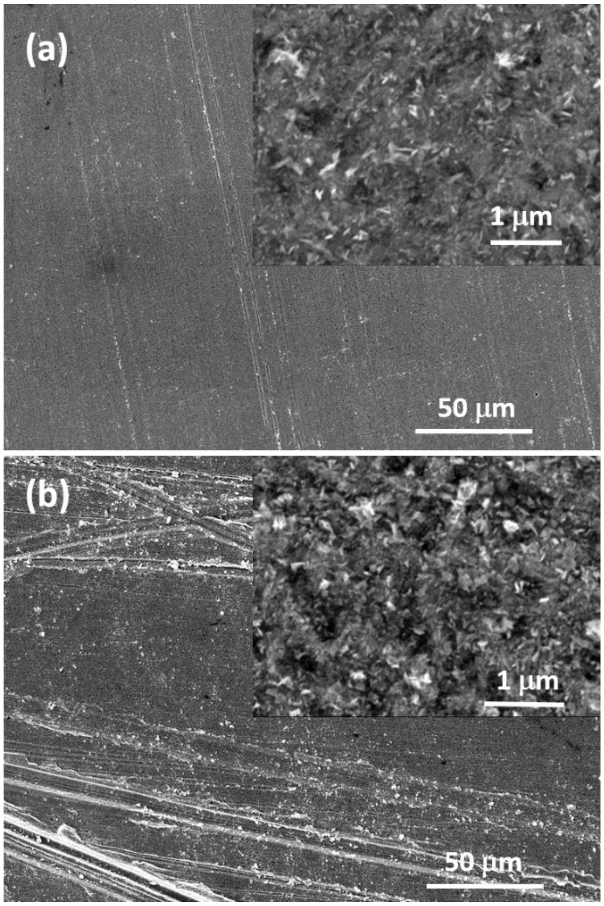

Figure S1. FESEM image of the CuO surfaces fabricated in (a) absence of scoring with sandpaper and (b) absence of H_2SO_4 treatment.

Determination of oxidation states:

The determination of Cu oxidation state is based on the combined analysis of the XPS Cu 2p, O 1s, and XAES Cu $L_3M_{45}M_{45}$ transitions. The O 1s components of Cu^+ and Cu^{2+} oxides are located at 530.4 and 529.4 eV, respectively. The Cu^+ state induces a chemical shift of -2.1 eV in the Cu LMM peak (E_K: 919.0 -> 916.9 eV), and a weak shakeup satellite in the Cu 2p region at +14.0 eV higher binding energy than the main peak. The Cu^{2+} state induces a chemical shift of -1.0 eV in the Cu LMM peak (E_K: 919.0 -> 918.0 eV), and a strong shakeup satellite in the Cu 2p region between +7.1 and +9.9 eV higher binding energy than the main peak which is broadened and shifted +1.2 eV compared to the Cu^0 state (E_B: 932.4 -> 933.6 eV). The modified Auger parameters, $E_B(Cu\ 2p_{3/2})+E_K(Cu\ LMM)$, of Cu^0, Cu^+, and Cu^{2+} are 1851.4 eV, 1849.3 eV, and 1851.6 eV, respectively.

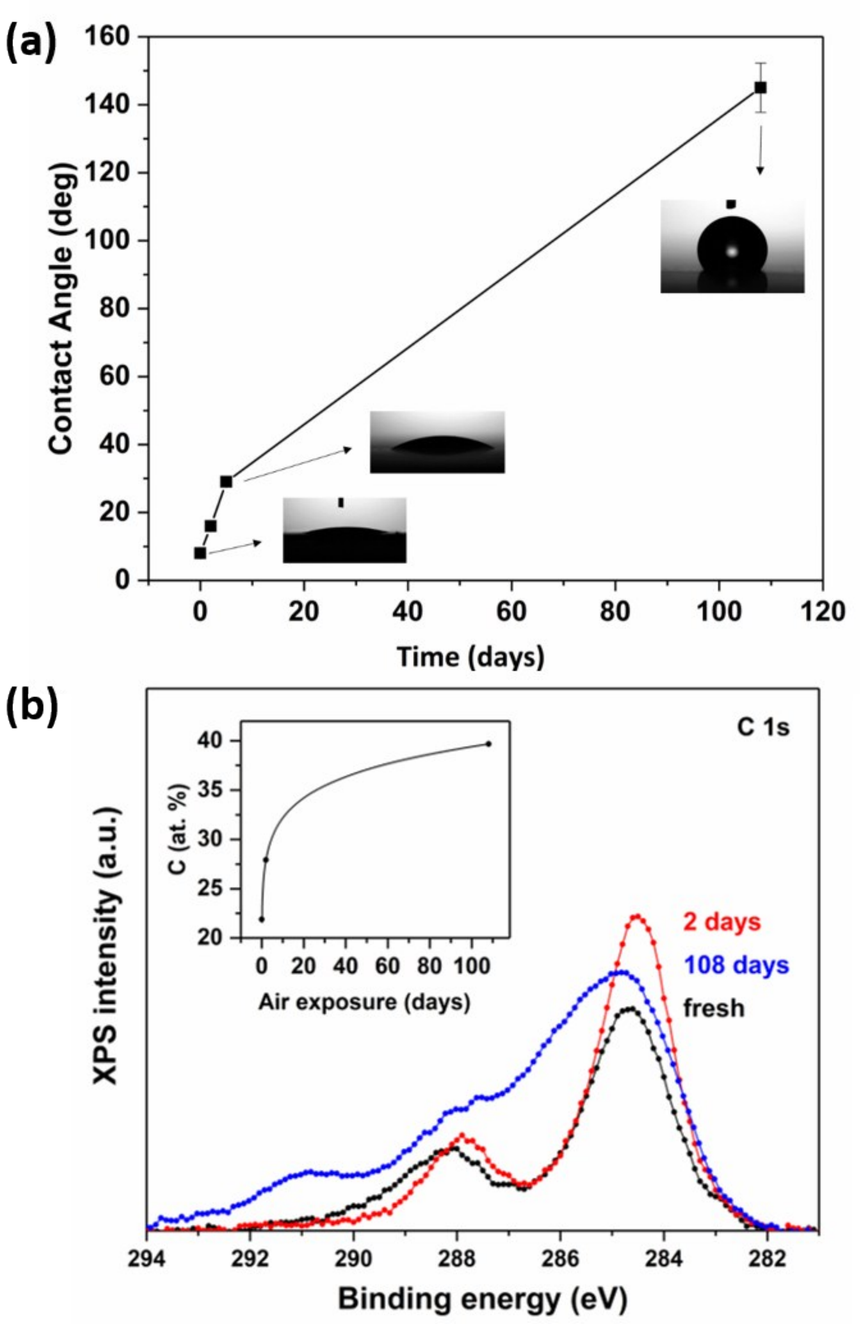

Figure S2. (a) Time-resolved wettability (contact angle) on uncoated CuO nanoneedle surfaces and (b) XPS spectra showing high-resolution spectra for C 1s at different exposure times: 0, 2 and 108 days. Inset shows the overall atomic percentage of adsorbed carbon (fitting line is just to guide the eye). The C 1s spectrum in case of 108 days sample broadens to higher binding energies, partly because of different volatile organic species adsorbed over the time in lab conditions.

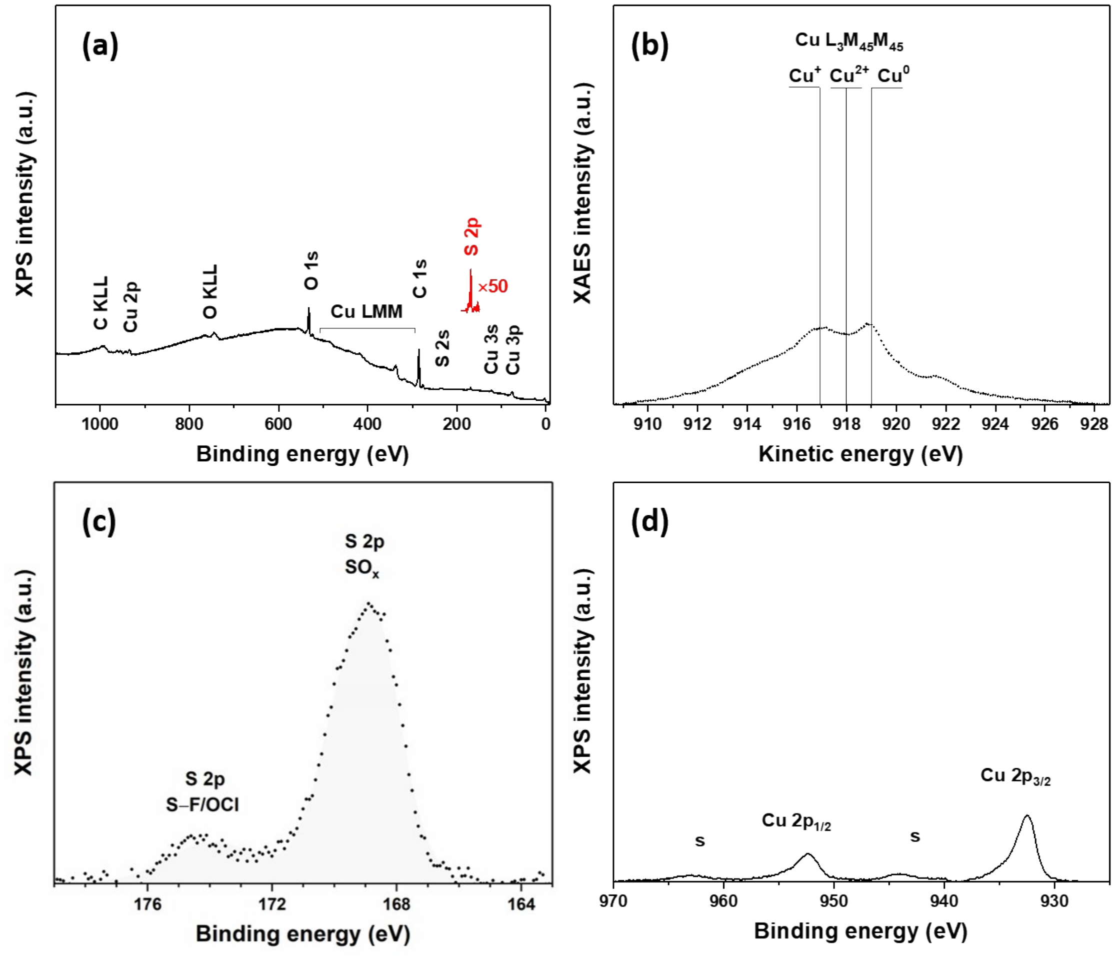

Figure S3. XPS Spectra of scored Cu Surfaces showing the bisulfate adsorption on to the surface. The data was taken just after the treatment of the surface with H_2SO_4 (a) XPS survey spectrum (black) and S 2p core level spectrum (red), (b) XAES Cu $L_3M_{45}M_{45}$ spectrum, Cu^0: 26.5 %, Cu^+: 62.1%, /Cu–Cl/F/S: 11.4 %, (c) XPS S 2p spectrum and (d) XPS Cu 2p core level spectrum (932.5 eV).

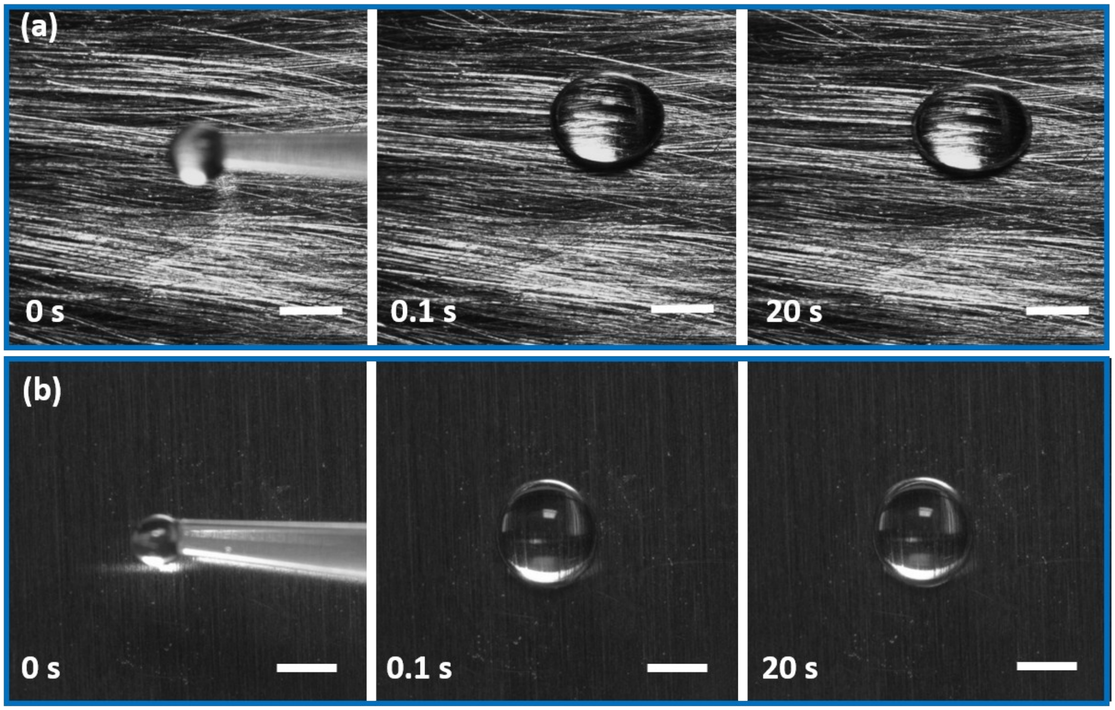

Figure S4. Images of a water droplet (1 μL) spreading on non-coated surfaces: (a) Scored Cu and (b) bare Cu at time 0, 0.1 and 20 s. Scale bar is 1 mm

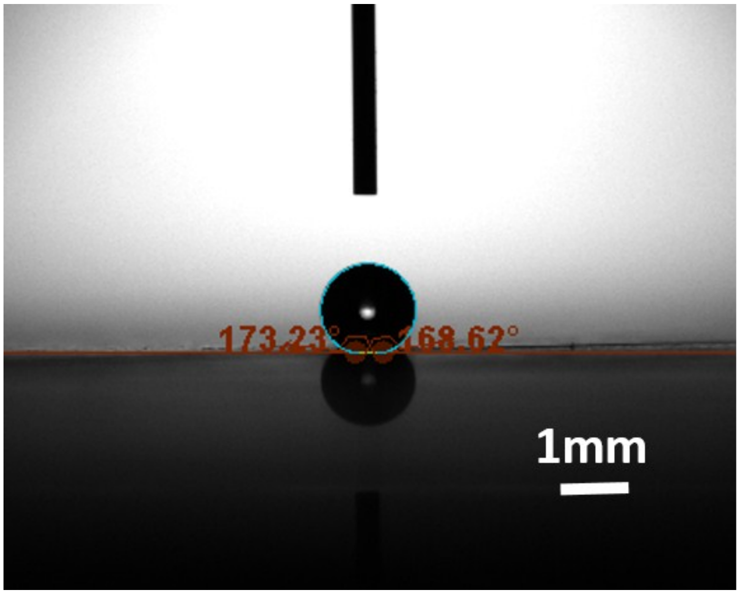

Figure S5. Contact angle of 1 μl water droplet on super hydrophobic CuO microneedles.

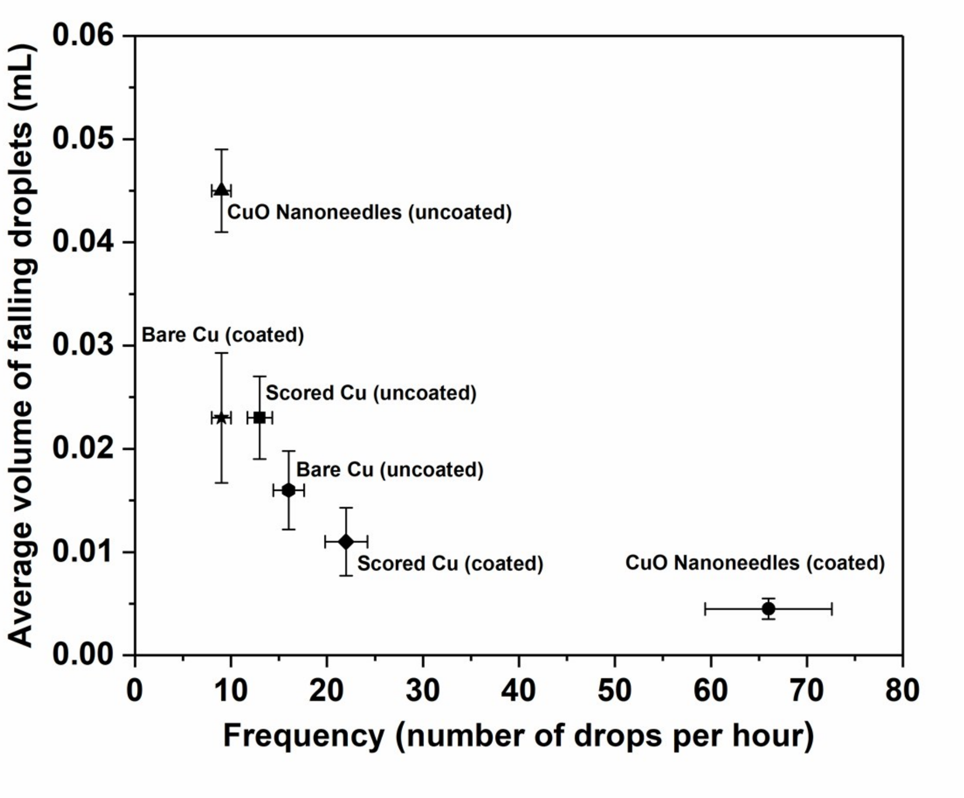

Figure S6. Average volume and frequency of the falling droplets (per hour) from the surfaces.

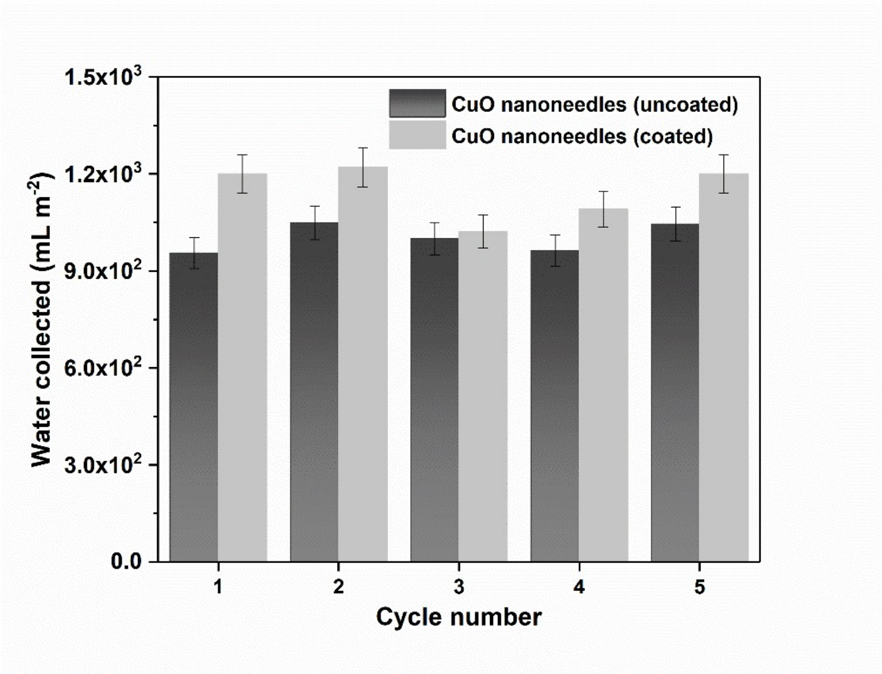

Figure S7. Reusability of the surfaces for water harvesting studies over the same patterned surfaces as water collected (mL m^{-2}) for 2h.