Supplementary Information

Electrical-Current Nanogeneration Driven by Spontaneous NanoFluidic Oscillations

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Experimental details

Crack-free mesoporous silica thin films deposited by dip-coating at 1.5 mm/s on silicon substrate (p-type, <100>, 5-10 Ω·cm) at RH of 45%, were prepared by the evaporation induced self-assembly (EISA) strategy using an inorganic precursor and a surfactant template in ethanol solution.[S1,S2] $Si(OEt)_4$ (TEOS) was used as the inorganic precursor, and Pluronics F127 was selected as the surfactant template. The silica precursor solutions were composed of TEOS:EtOH:H_2O:F127 with a ratio of 1:40:5:0.04 to synthesize the wormlike pore structure. After deposition, the films were calcined at 450 °C for 10 minutes. For comparison, nonporous films were made as described, but in the absence of the polymeric template. To obtain the ordered pore structure the ratio of the precursor solution was 1:40:5:0.075 and after deposition, the films were placed in 50% RH chamber overnight, then they were subjected to a consolidation thermal treatment, which consisted of 24 h at 60 °C, 24 h at 130 °C, and finally calcined at 350 °C for 2 h (temperature ramp of 1 °C/min). The Cu gate electrodes (200 nm thick and 1 mm in diameter) were deposited by sputtering and patterned using a physical mask.

For the mesoporous film characterization, electron microscopy images were obtained using a ZEISS LEO 982 GEMINI field emission electron microscope in the secondary-electron mode, using an in-lens detector to improve resolution, and transmission electron images were taken using a Philips CM200 electron microscope.

Current generation experiments were carried out by placing a drop of Milli-Q water (1μl) on the mesoporous film, 120 μm apart from the electrode at 25°C and 40-45% relative humidity. Electrical measurements were recorded using a SMU Keithley 2612A (Cleveland, OH) measuring current vs time. Fluid motion was followed using a Mitutoyo FS70 microscope. Images were recorded using a high-resolution digital camera.

S1. M. Mercuri, K. A. Pierpauli, C. L. Berli and M. G. Bellino, *ACS Applied Materials & Interfaces*, 2017, **9**, 16679-16684.

S2. G. Soler-Illia, P. Angelomé, M. Fuertes, A. Calvo, A. Wolosiuk, A. Zelcer, M. Bellino and E. Martínez, *Journal of Sol-Gel Science and Technology*, 2011, **57**, 299-312.

Light intensity analysis

Measured light intensity is expected to be proportional to the instantaneous amount of water into the films, thus one may study the correlation between light intensity and the generated electrical current, which were simultaneously measured. For this purpose, the time-dependent light intensity profile near the electrode was calculated as follows: each data point was defined as the average over several pixels in the 50μmx250μm rectangle shown in Fig. S1. To maximize the contrast, the information considered was the difference ΔI between blue and red light intensity from the RGB channels, at time intervals of 0.25 s. Finally ΔI was divided by the intensity value measured when the drop was completely dried, which was taken as the reference I_{ref}. The resulting relative intensity $\Delta I/I_{ref}$ as a function of time was plotted together with the electrical current in Fig 3c (main text).

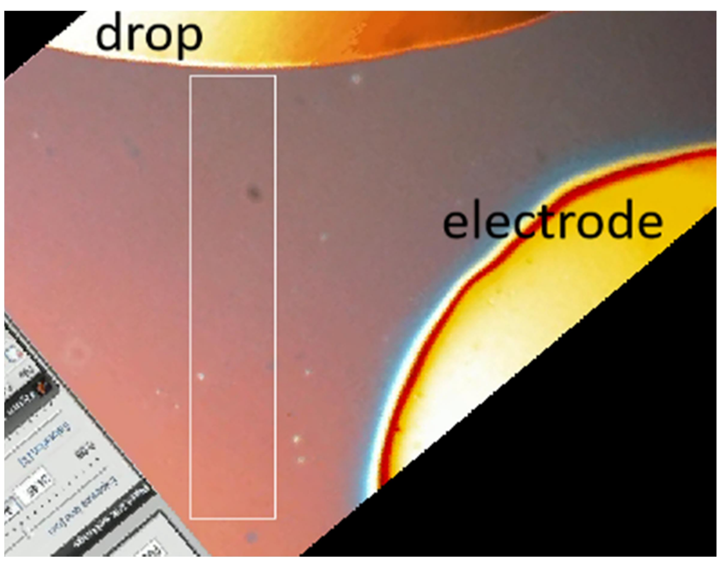

Figure S1: The image shows the domain (white line rectangle) where light intensity data was analyzed during the time lapse of the current generation experiment. Results are shown in the main text, Fig. 3c.

Additional test regarding the meso-MOS variable capacitor as an electrostatic generator (Figures S2 to S5)

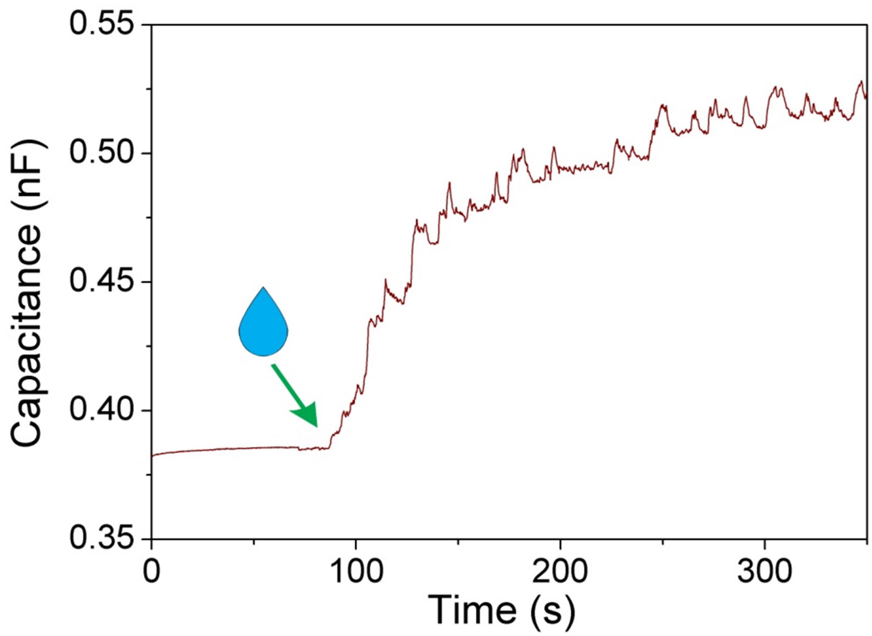

Figure S2: Capacitance in accumulation condition versus time in the wormlike MOS system after a sessile drop of water was deposited onto surface.

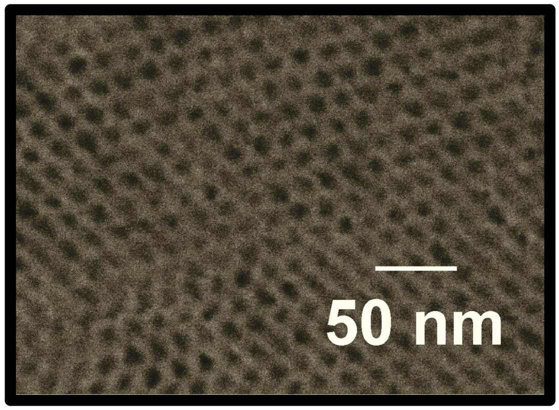

Figure S3: SEM characterization of the ordered mesoporous silica films.

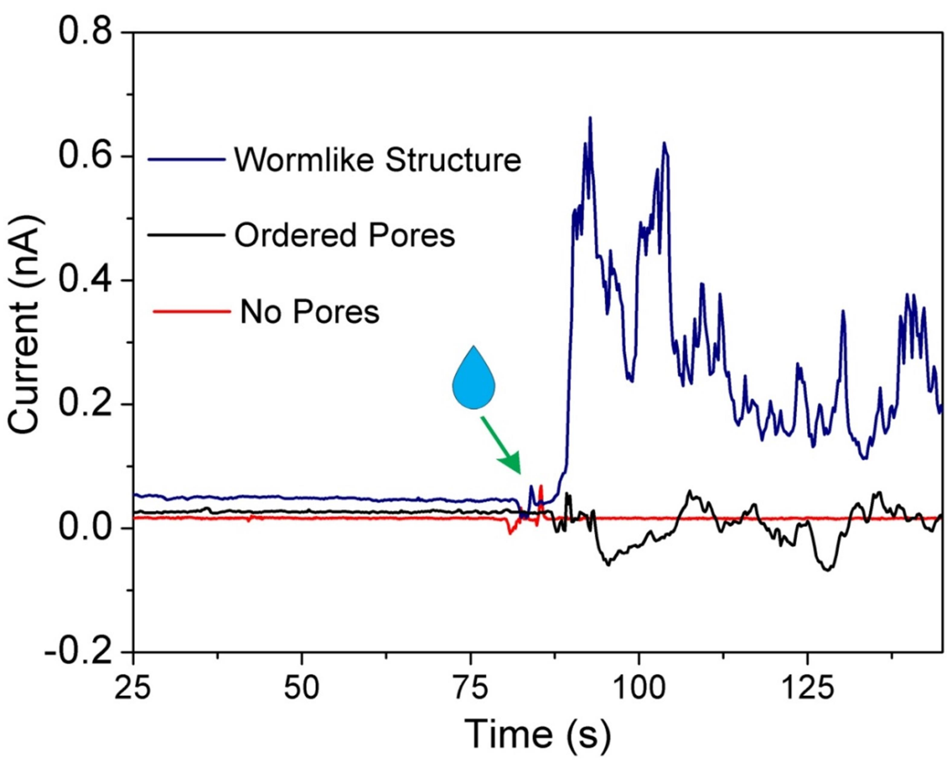

Figure S4: Current response of the nonporous and the ordered porous layer MOS system when a water drop is deposited on the film. The response of the wormlike MOS system is given for comparison.

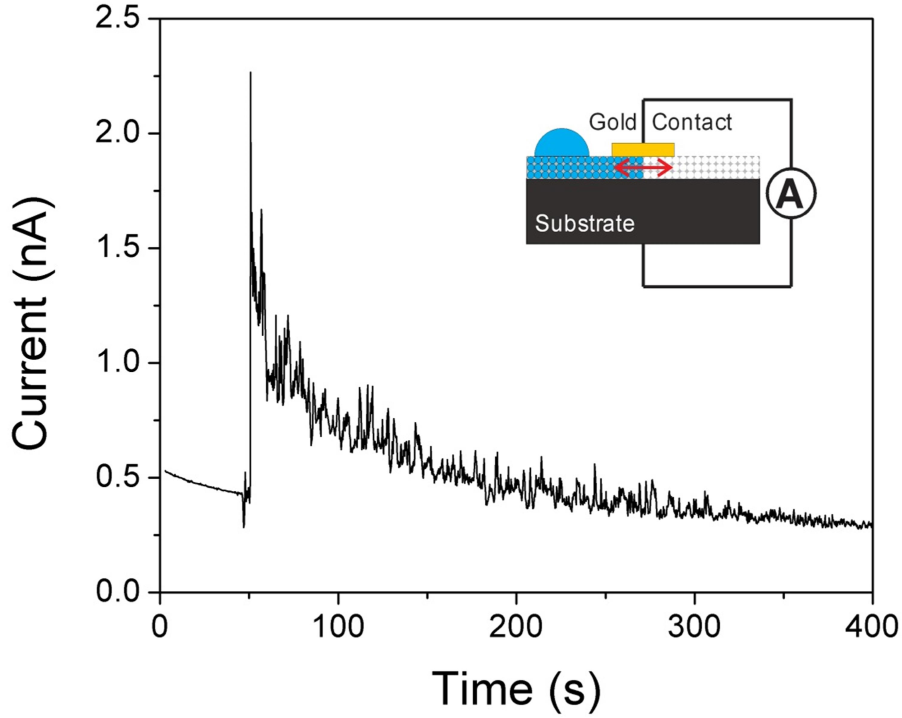

Figure S5: The current measured with a gold top-electrode system when the water drop is deposited on the film.