Supporting Information

Hierarchical Silicon Nanospikes Membrane for Rapid and High-Throughput Mechanical Cell Lysis

Hongyun So,[†,*] Kunwoo Lee,[‡] Young Ho Seo,[§] Niren Murthy,[‡] and Albert P. Pisano[†]

[†]Department of Mechanical Engineering, Berkeley Sensor & Actuator Center and [‡]Department of Bioengineering, University of California, Berkeley, CA 94720, United States

[§]Department of Mechanical and Mechatronics Engineering, Kangwon National University, Chuncheon, Gangwon-do 200-701, South Korea

[*] Author to whom correspondence should be addressed. E-mail: hyso@berkeley.edu.

Fabrication of the HSSM

In this study, n-type <100> silicon wafer with 10-20 Ω-cm resistivity was etched in 5.2-wt% HF acid for 210 min at room temperature. The back side of the wafer was illuminated using a near ultraviolet (UV, 365 nm wavelength) light source (Spectronics Corporation, NY). An ethanol with 1% (v/v) was mixed with HF acid to remove hydrogen bubbles trapped in trenches during the PEC etching. The applied bias voltage and current density during PEC etching were remaining steady at 3.6 V and 8.6 mA/cm^2, respectively. The back side of the wafer was additionally patterned using a photoresist by standard photolithography and etched through-hole by deep reactive-ion etching (DRIE) to form the desired diameter for the prepared filter holder and to handily release the membrane from the wafer, respectively (Figure 1).

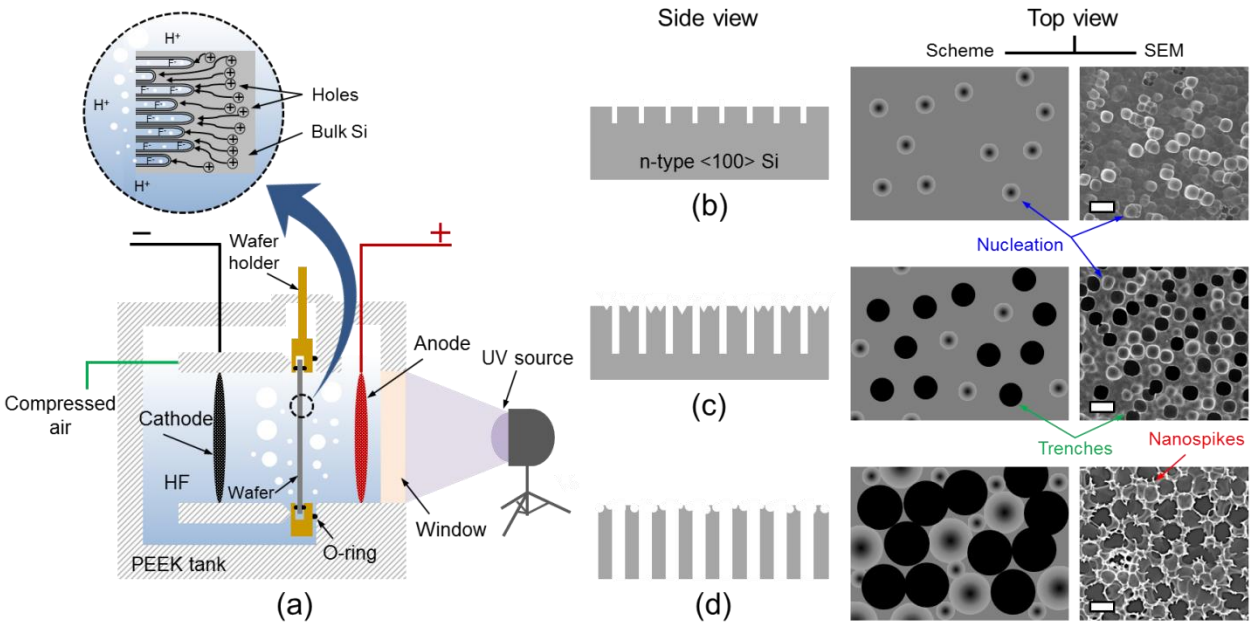

Figure S1. Schematic illustration of the HSSM fabrication process and SEM images with different anodization times: (a) photoelectrochemical etching, (b) initiation of trenches at random positions, (c) sequent formation of new trenches with increasing time, and (d) formation of ultrasharp nanospikes with a long anodization time. Scale bars: 10 μm for (b), (c), and (d).

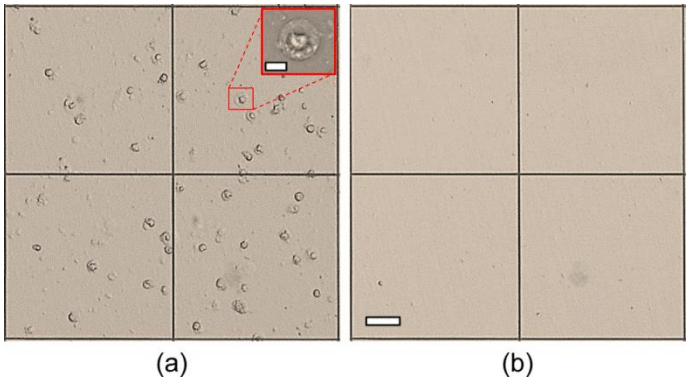

Figure S2. Optical microscope image (a) before and (b) after HaCaT cell lysing. Scale bars: (a) 10 and (b) 50 μm.

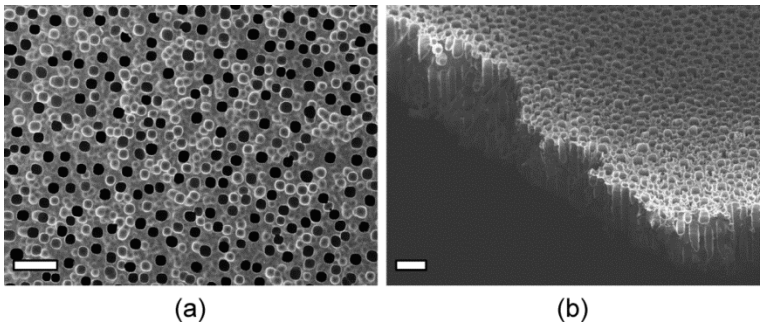

Figure S3. SEM images of the nonspikes silicon membrane anodized for 100 min: (a) top surface view and (b) 45° tilted view. Scale bars: (a) 20 and (b) 20 μm.

Cell preparation

For all lysis approaches including mechanical, acoustic and chemical methods, immortalized human keratinocyte (HaCaT) and Hepatocellular carcinoma cell-line (HepG2), gifts from Berkeley Tissue Culture Facility, were cultured in a 5% (v/v) CO_2 incubator at 37 ℃ and maintained in Dulbecco's modified eagle medium (DMEM, Gibco), supplemented with 1% (v/v) penicillin-streptomycin (10,000 units/ml, Gibco) and 10% (v/v) fetal bovine serum (FBS, Gibco). The cells were cultured for a week prior to the experiment and detached from the culture dish via 0.05% trypsin-EDTA (Life Technologies) treatment and then suspended in culture media before the lysis experiment. In order to compare the amount of intracellular proteins and nucleic acids in

the lysate from the same amount of cells, the cells with a concentration of 10^6 ml^{-1} in phosphate buffered saline (PBS, pH 7.4, Gibco), which was used to remove remnant proteins or nucleic acids in culture media, were counted by a hemocytometer before lysis and analyzed for all cell lysis methods.

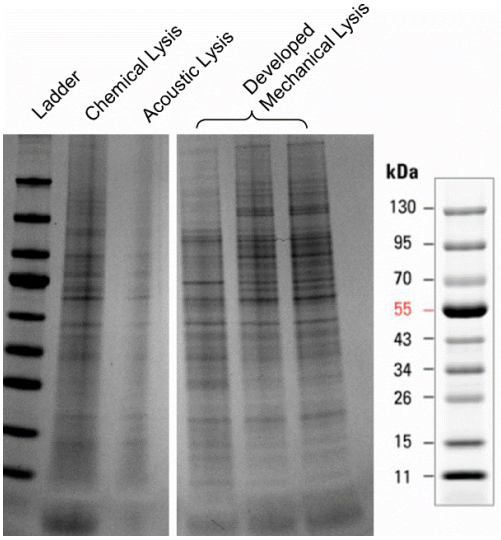

Figure S4. Comparison of the HaCaT cell protein species separated by gel electrophoresis between the developed mechanical cell lysis method and conventional methods.

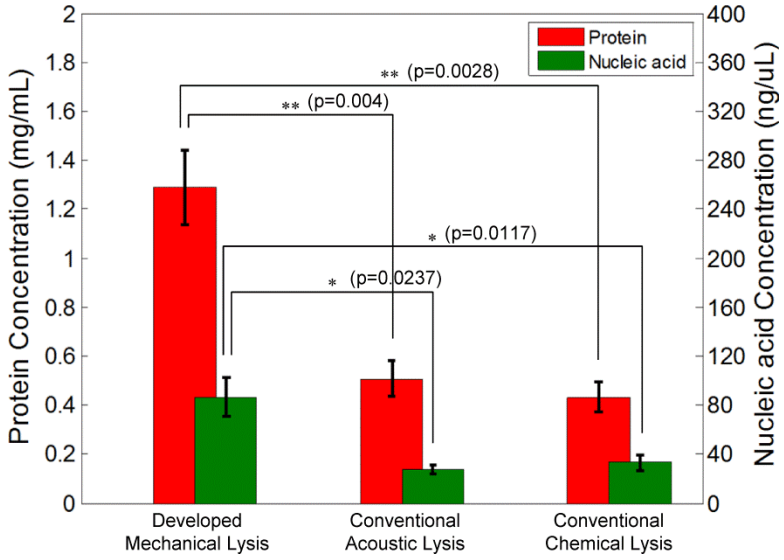

Figure S5. Comparison of protein and nucleic acid concentrations after HepG2 cell lysing between the developed mechanical cell lysis method and the conventional methods.