Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Facile fabrication of sponge-like porous micropillar arrays via electrochemical process

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FEA Methods

We used the COMSOL Multiphysics software to calculate the current flow and electric field distribution around a single micropillar (Figure S1). A three-dimensional model with the same size as the fabricated micropillar was built by the embedded geometrical model builder. The materials' parameters for the domains of the model are listed in Table S1. The Electric Currents interface was applied to all domains of the model to compute the current and potential details. Then we chose Stationary study to obtain the solutions. For the boundary settings, a normal current density (10 mA/cm^2) was applied at the backside of the model. A terminal setting with zero potential was applied at the upper boundary of the model to serve as the reference for the calculation.

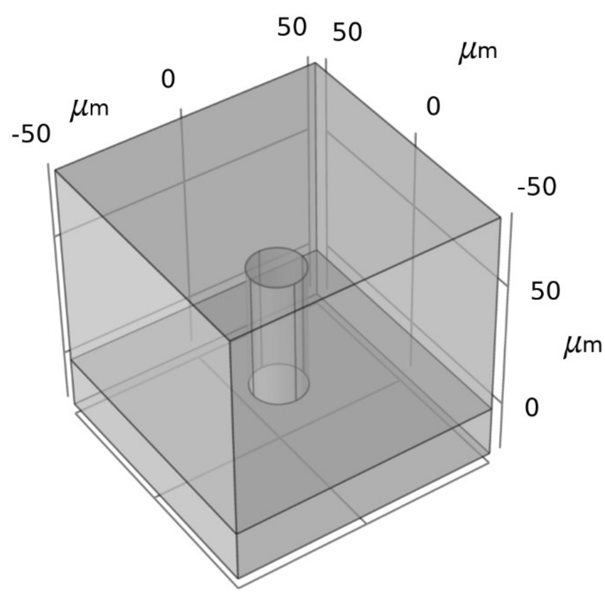

Fig. S1. Geometrical model of the etching cell

Table S1. Material properties of the domain in the model

Domain	Electrical conductivity(S/m)	Relative permittivity
Electrolyte (HF solution)	12.5	83.6
Silicon	1e4	11.7

Table S2. Structural parameters of micropillars for simulation

No.	*Height (μm)*	*Diameter (μm)*	*Aspect ratio (Height: Diameter)*
1	40	20	2:1 (>1)
2	20	20	1:1 (=1)
3	20	40	1:2 (<1)

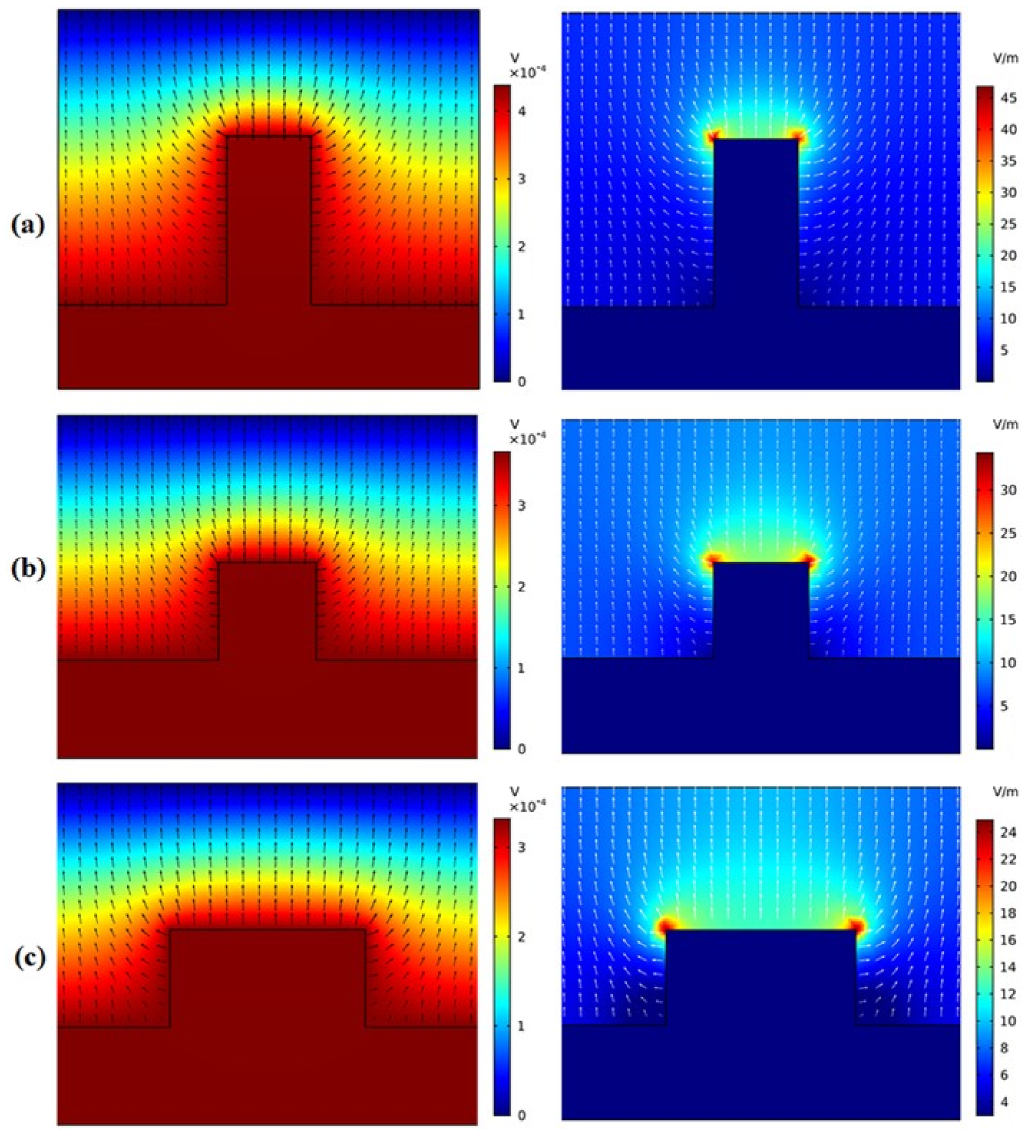

Fig. S2. The distribution of current flow density and electric field along the micropillars with different aspect ratios. The aspect ratios in (a)-(c) are 2, 1 and 0.5, respectively. The current flows perpendicularly through the interfaces in all three groups. Besides, the changing trends of the current density across the interface are consistent with one another among the three groups. The results are also consistent with the simulation results shown in the main text.

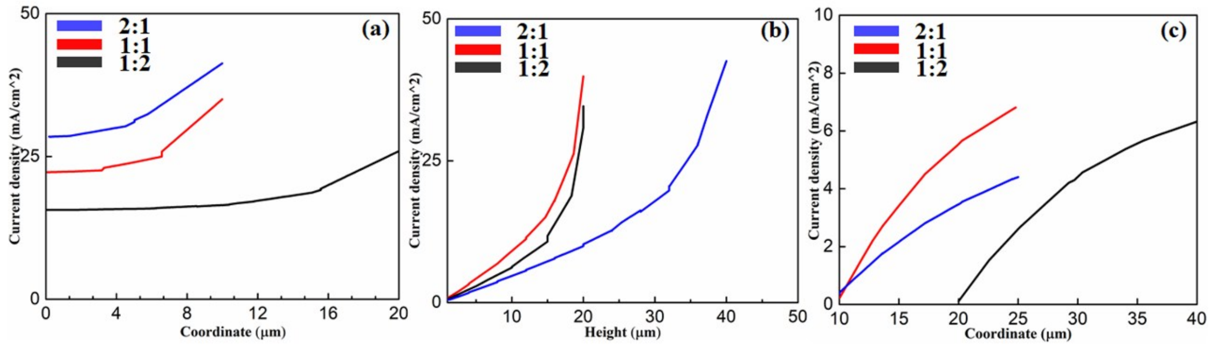

Fig. S3. Distribution of current density along micropillars with different aspect ratios. (a)-(c) represent the changes of the current density along the top surface, sidewall and bottom surface, respectively. It should be noted that the current density reaches the maximum at the top corner, which appears to have a positive correlation with the aspect ratio.

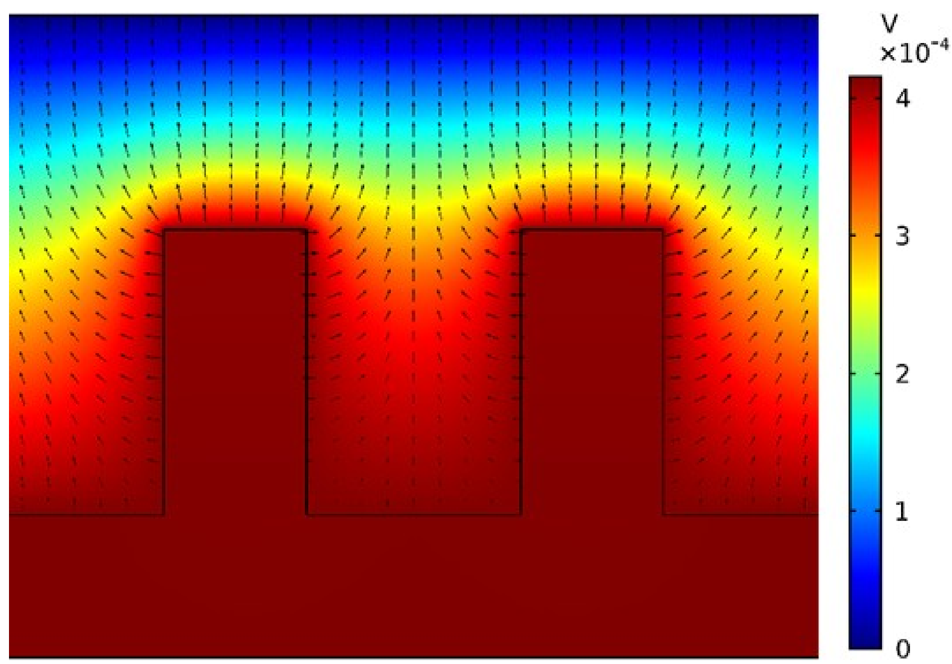

Fig. S4. . Current density around two adjacent micropillars. Although the electric field coupling has an obvious impact on the current distribution, the current can still flow perpendicularly across the interface.

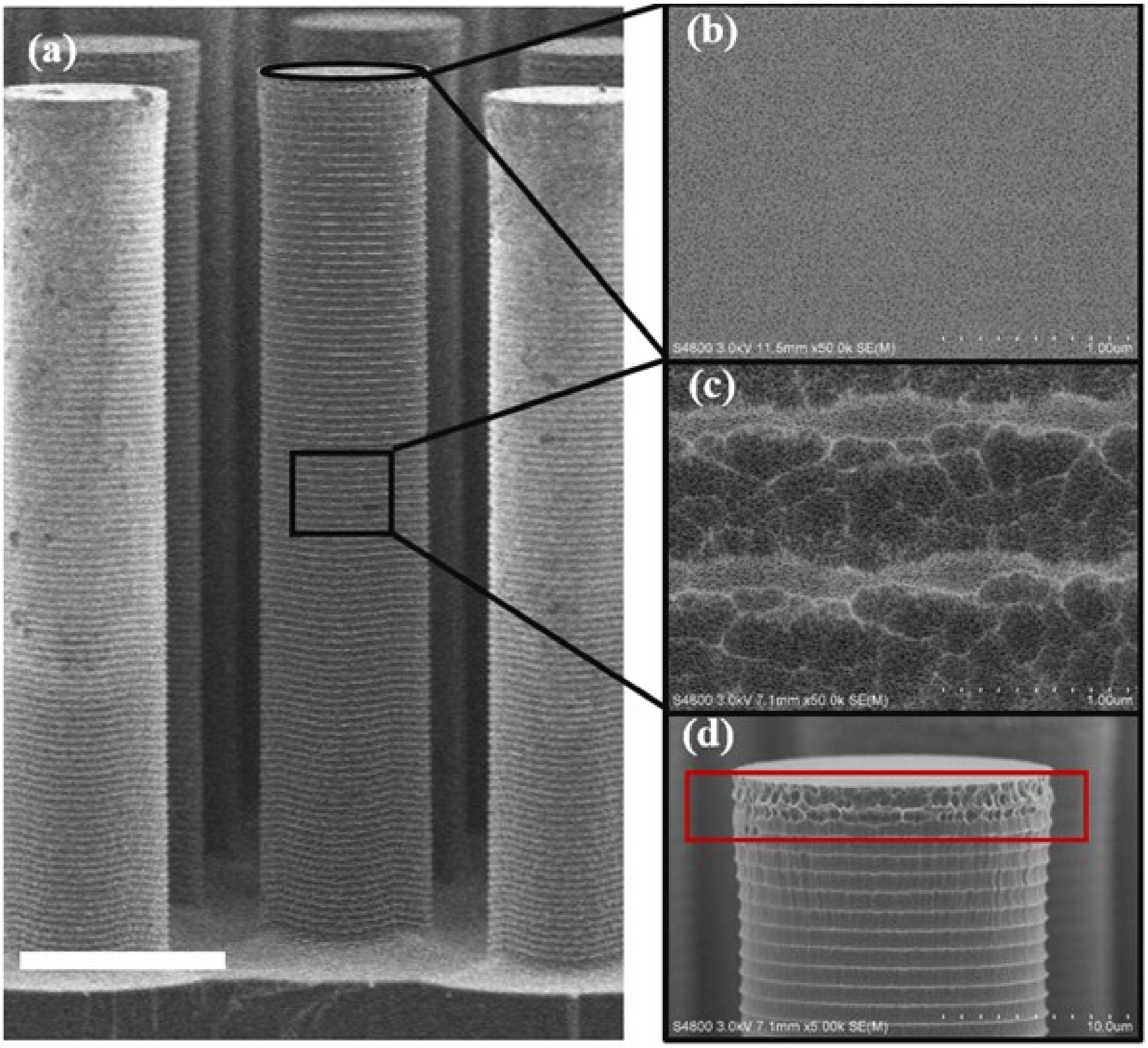

Fig. S5. Scanning electron microscope (SEM) images of porous micropillars with an aspect ratio of 5. Scale bar in (a) is 20 μm. The nanopores can still be formed on the surface. However, electropolishing effect is observed at the upper corner of the micropillar, as indicated by the red box in (d). It makes sense according to the simulation results that a higher aspect ratio corresponds to a higher current density flowing through the top corner. Therefore, this result can be interpreted that the current density flowing through the top corner is high enough to result in electropolishing in the case of micropillars with high aspect ratios.

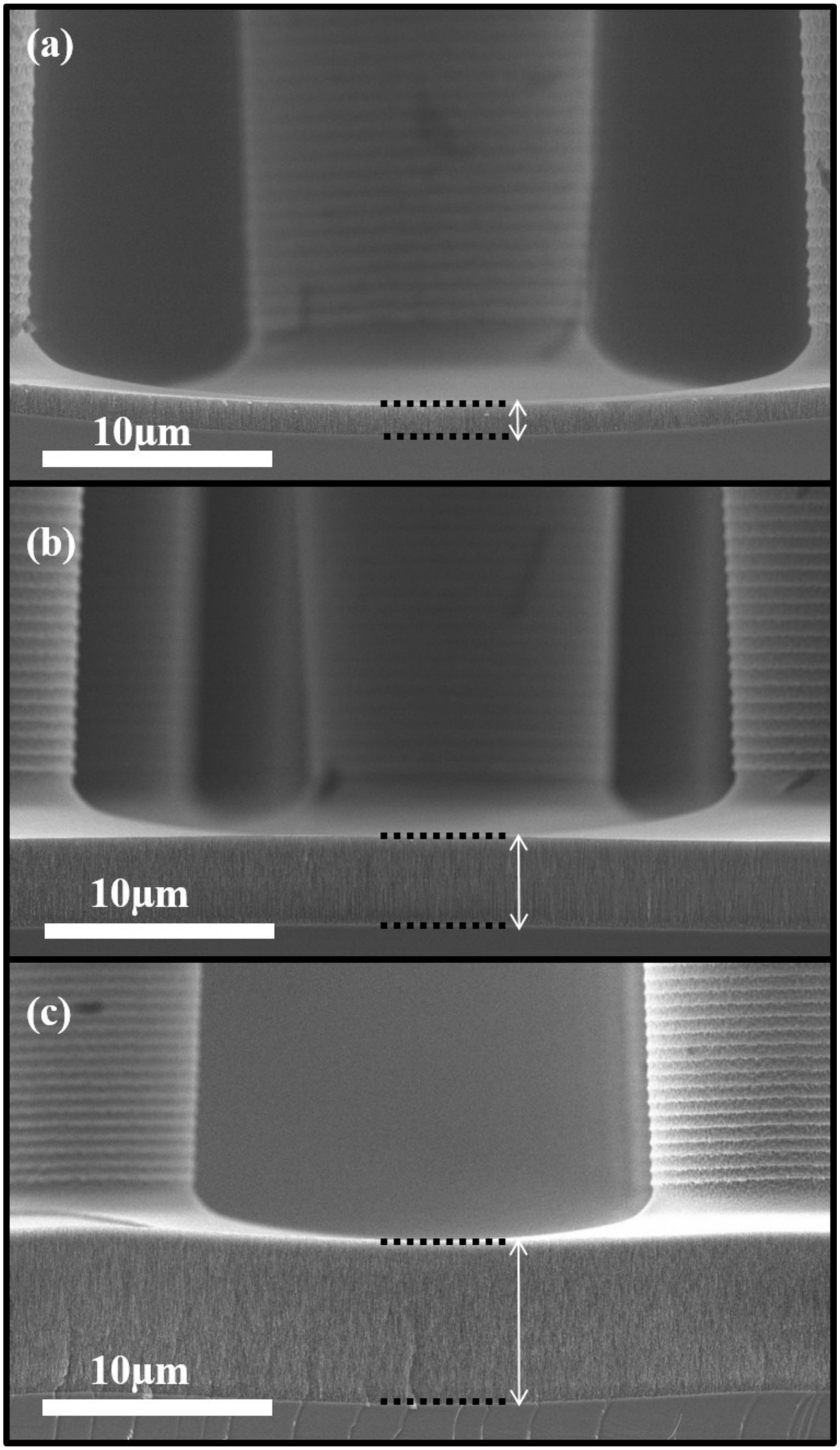

Figure S6. Side-view SEM images of bottom surfaces and top-view of top surfaces. (a) 10-min etching; (b) 30-min etching; (c) 50-min etching.

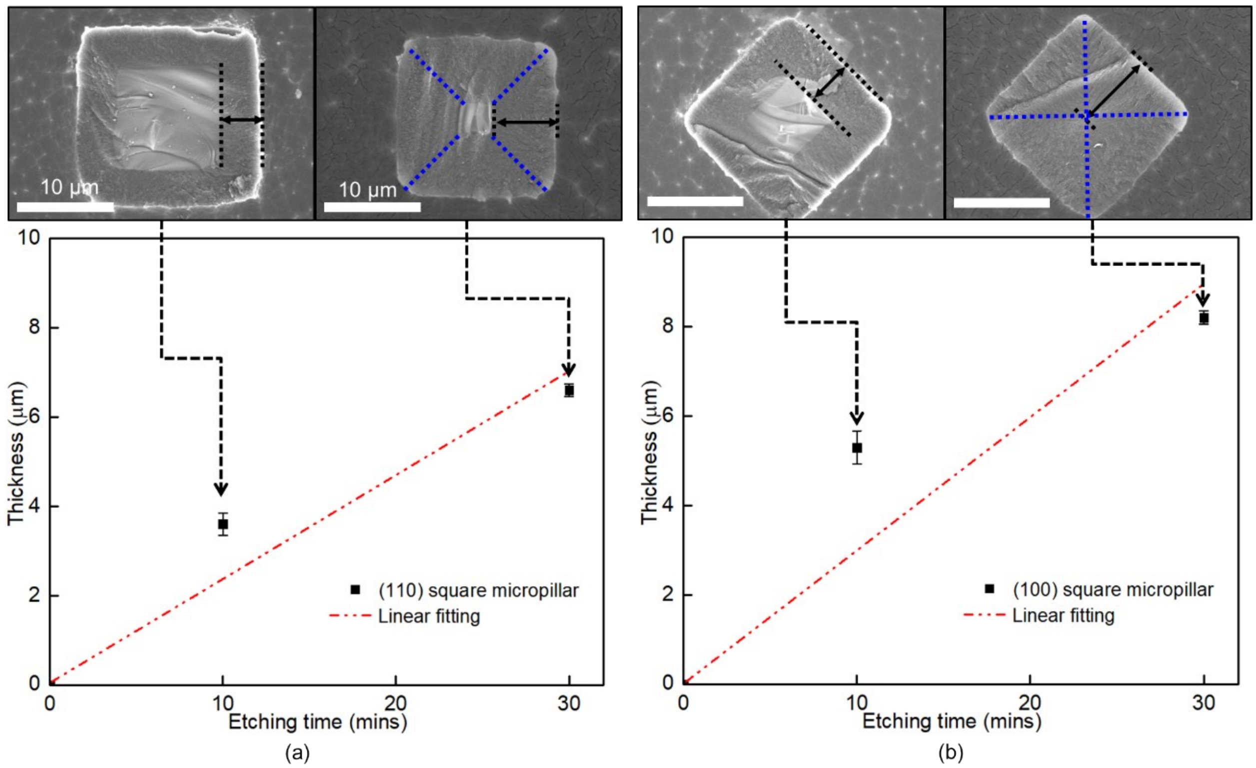

Figure S7. Change in the thickness of a nanoporous layer with respect to the etching time. (a) Square micropillar exposing (110) planes. (b) Square micropillar exposing (100) planes. The dashed lines are linear fitted lines and their slopes represent the etching rates. The thickness of a nanoporous layer on the square micropillar also exhibits a roughly linear relationship to the etching time, but with different etching rates along different directions. The etching rates for (a) and (b) are 0.23 µm/min and 0.30 µm/min, respectively.

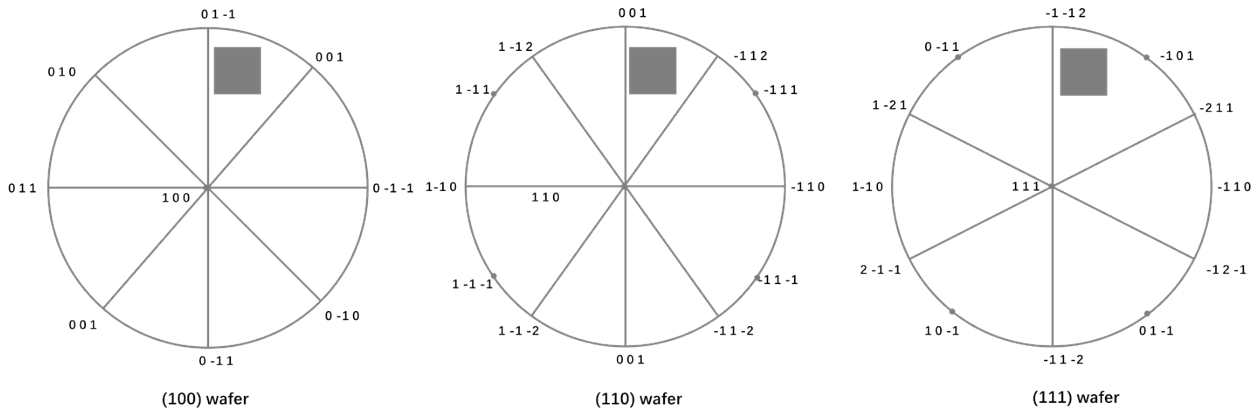

Figure S8. Stereographic projection for (100), (110) and (111) silicon wafers. Taking a square micropillar for example, it would expose four (110)-equivalent planes on (100) wafer. However, for (110) wafer, it would expose two (110) planes and two (100) planes. For (111) wafer, it would expose two (110) planes and two (112) planes.