Supporting Information: Photo-patterned Oxygen Sensing Films for Controlling Cell Growth and Studying Metabolism

Fei Zeng[a, #], Zengju Fan[a, #], Shanshan Wu[b, *], Xing Cheng[a, *], Yanqing Tian[a, *]

a. Department of Materials Science and Engineering, Southern University of Science and Technology, No 1088 Xueyuan Blvd, Xili, Nanshan District, Shenzhen, Guangdong, 518055, China

b. Guangdong Industry Polytechnic, No. 152 Xingang West Road, Haizhu District, Guangzhou, 510300, China

#: equal contribution

The detailed procedure for the preparation of the patterned films (Fig. S1):

Firstly, light mask (only the spacer region is opaque) with rectangles in edge was designed. Then, positive resist (RZJ304) was chosen to spin-coated onto the silicon wafer at 1800 RPM to get a resist layer with 3μm in thickness. The soft-bake was in 90°C for 3 minutes. Next, the resist layer was exposed under 365nm light sources for 9s with the designed mask. After 10 s post-exposure bake (120°C), the resist layer pattern can completely satisfy with the need for Inductively Coupled Plasma (ICP) etching. The pattern was then transferred from the resist layer to the silicon wafer by ICP etching. In this process, a protective layer was made by photoresist around the surface of quartz glass substance, which would protect quartz glass in this region from etching process. After being ICP etched, this protective layer was removed from quartz glass and spacer around the surface of quartz glass formed (Fig. S1a).

After that, the quartz glass was cleaned via alcohol, acetone and oxygen plasma treatment. Then the quartz substrates were modified with TMSPA ((3-(Trimethoxysilyl) propyl acrylate) for ensuring sensor and matrices to be chemically grafted onto the quartz surface[1]. Besides, masks were duplicated before photolithography process for avoiding polluting original masks later (Fig. S1b). In this process, as light source chosen is 405nm, which means that the exposure process cannot be finished directly on the traditional mask alignment machine. The 200nm Cr layer was obtained on the silica wafer by electron-beam evaporation. Masks with different line-widths (5μm, 7μm, 10μm, 20μm, and 50μm) equal-ratio gratings were designed. Also, the positive resist was spin-coated on the Cr layer and the following photolithography process is the same as what has been mentioned above. Then the pattern was wet-etched in Cr etchant, whose rate of process could be megascopic. After the resist layer removed, the masks for the ultimate exposure were obtained. Replicated masks were totally same as the designed masks. To make sure the surface energy difference between the mask and the substance, the mask was treated in 1H,1H,2H,2H-perfluorodecyltrichlorosilane (FDTS) to lower the surface energy before UV-cured process.

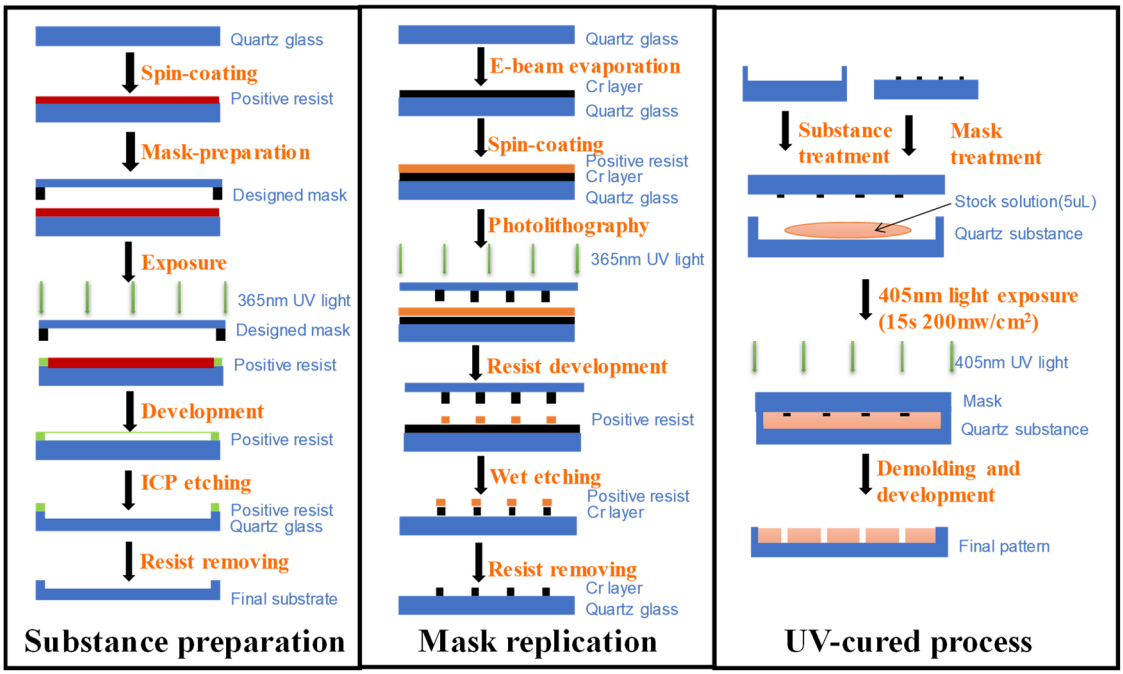


Fig. S1. A sketch shown processes in photo-lithography for micropatterned films' preparation: Photolithography printed photomasks with gratings' structures in different widths. a) substance preparation; b) mask replication; c) UV-cured process of stock solution

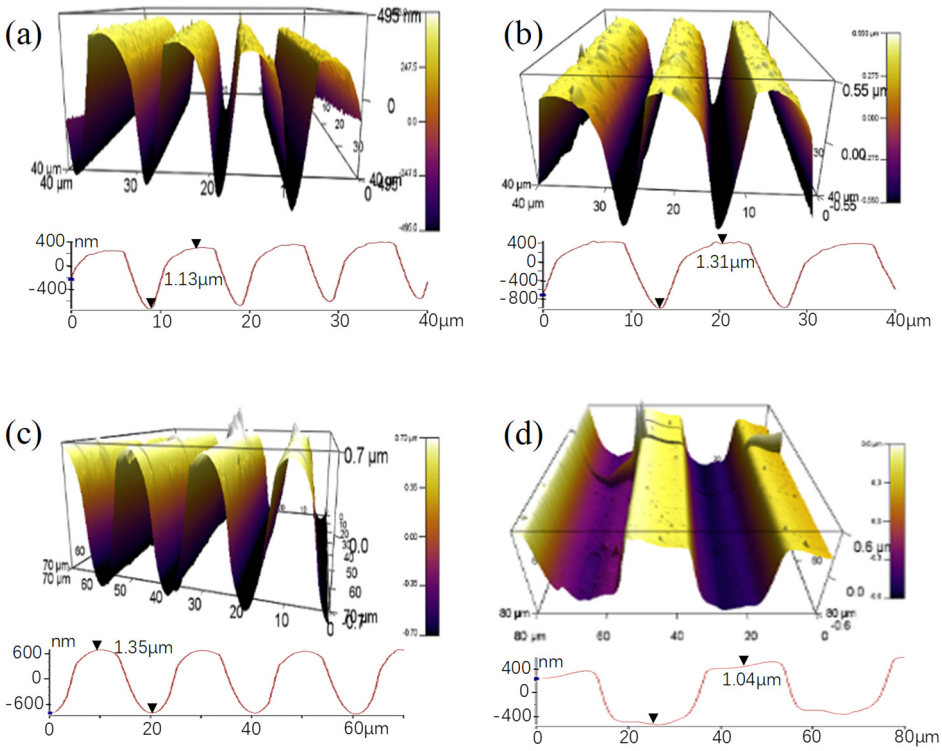


Fig. S2. AFM images of patterned films with grating width in 5 μm (a); 7 μm (b); 10 μm (c); and 20 μm (d).

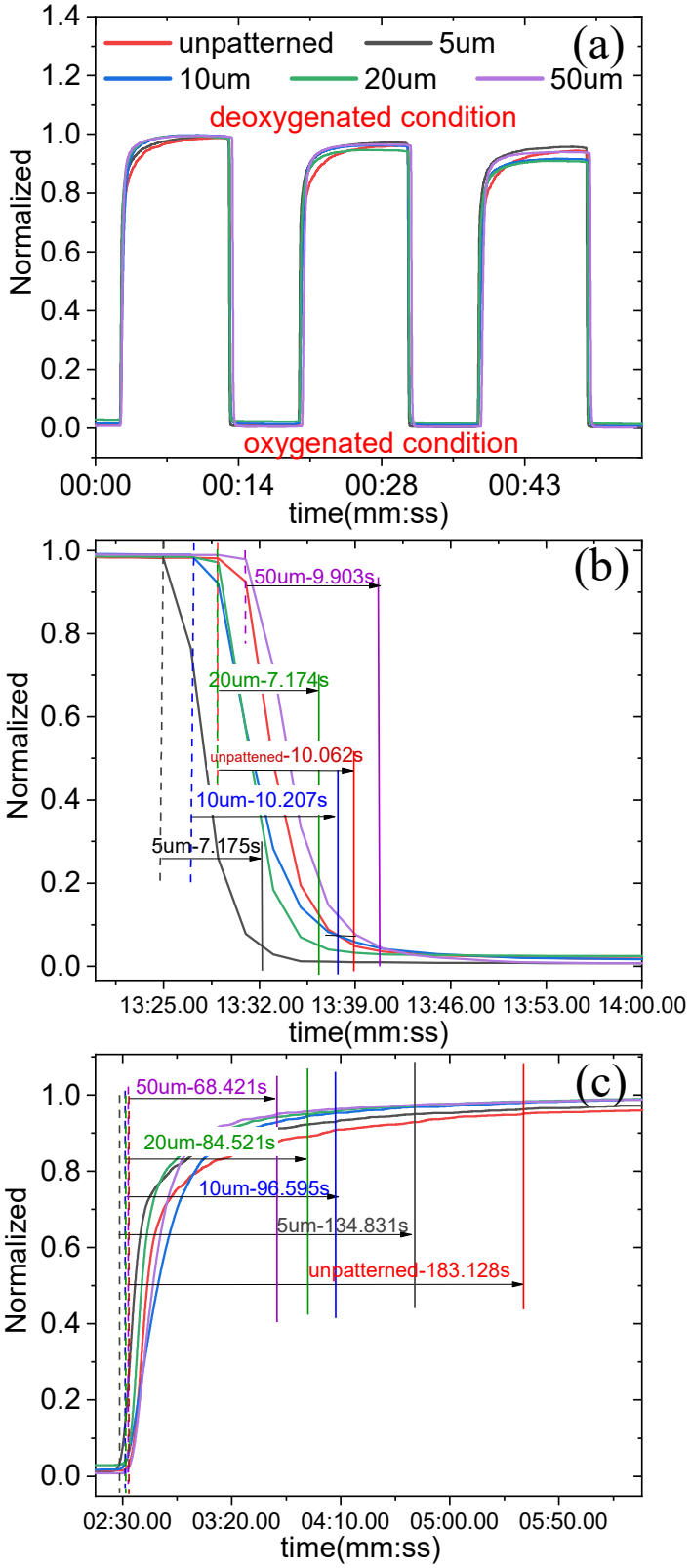


Fig. S3. (a) Response time of sensing films with different grating widths; detailed curve profiles for the demonstration of the response time (b) and recovery time (c), respectively, for each of the sensing film.

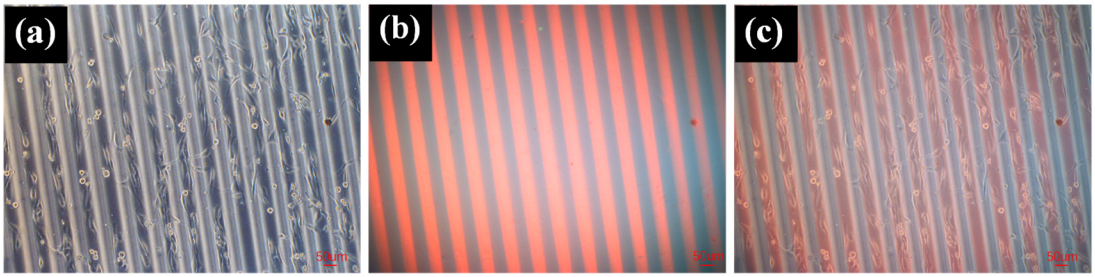


Fig. S4. Microscopic images of HeLa cells grown on film with grating width in 50 μm under bright field (a) and UV light excited fluorescent field (b). (c) Overlap image of (a) and (b).

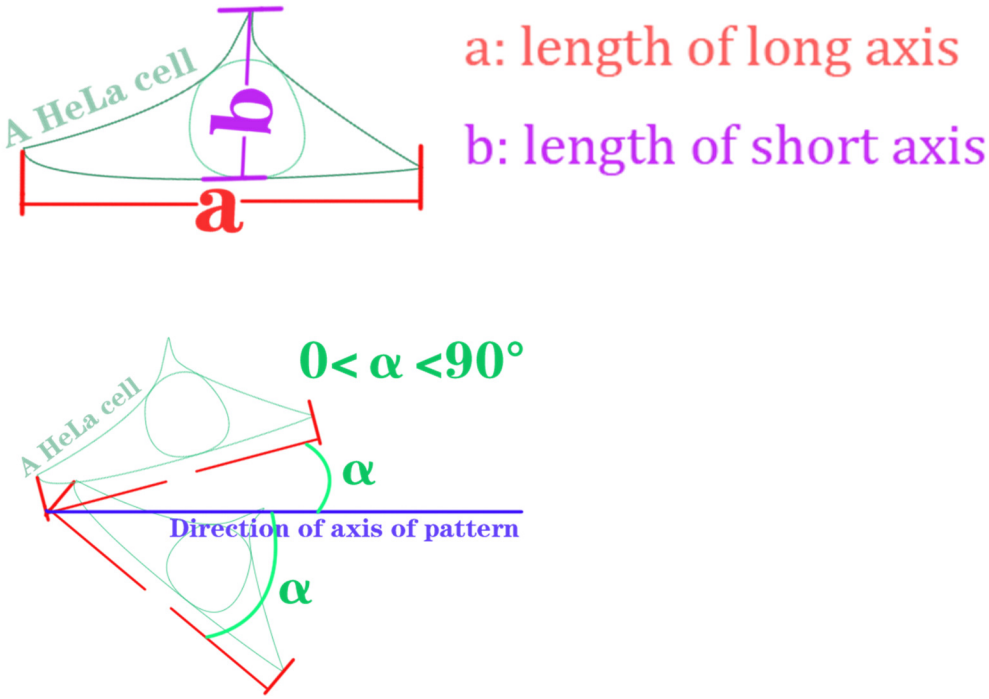


Fig. S5. A sketch to show how were elongation ratios (length of long axis/ length of short axis) and alignment angles (included angle between direction of cell long axis and the grating on film) calculated.

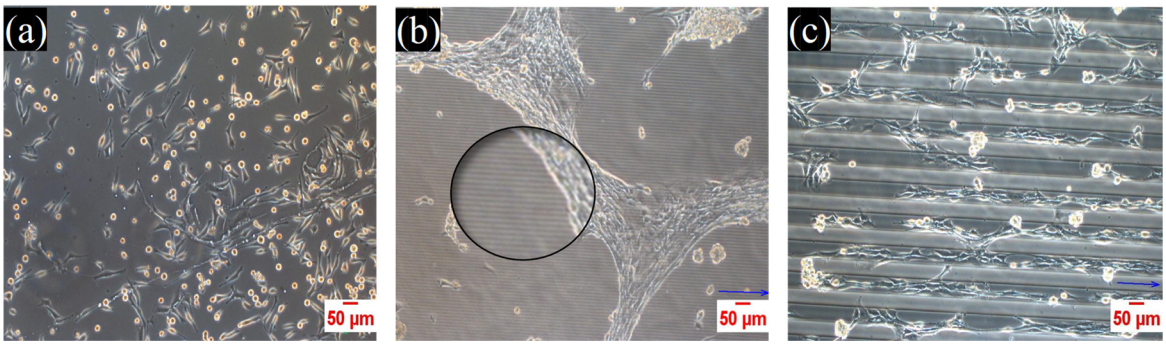


Fig. S6. 3T3-L1 fibroblasts attachments after 24 hours culture on the non-patterned (a), 5 μm featured patterns (b), 50 μm featured patterns (c).

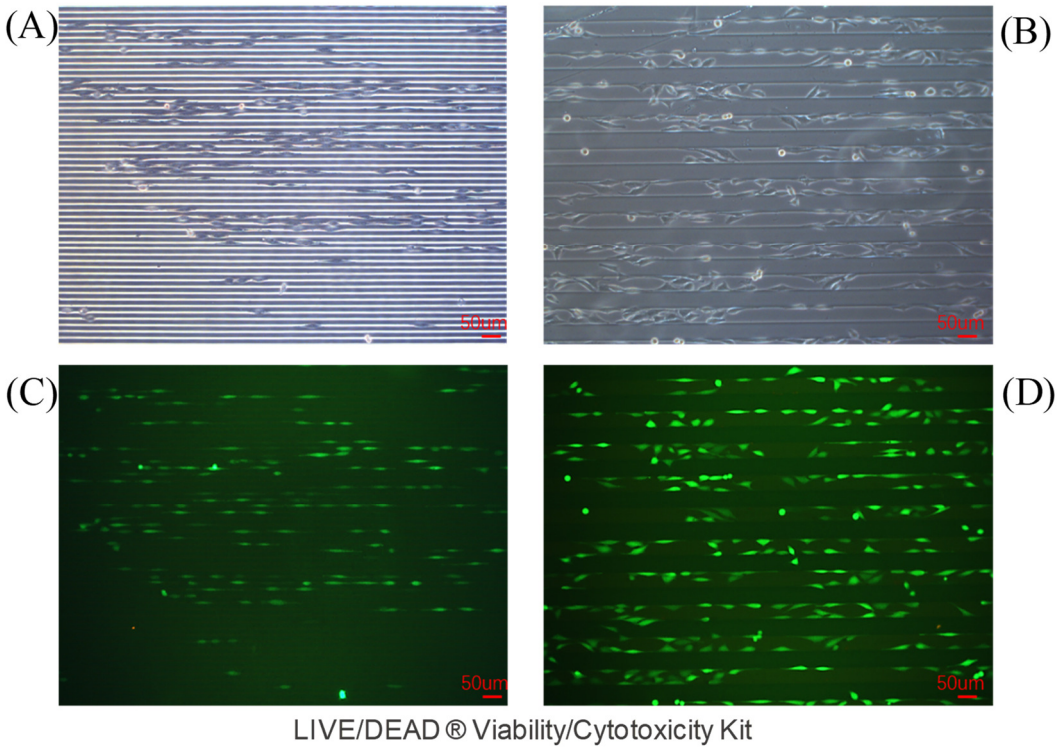
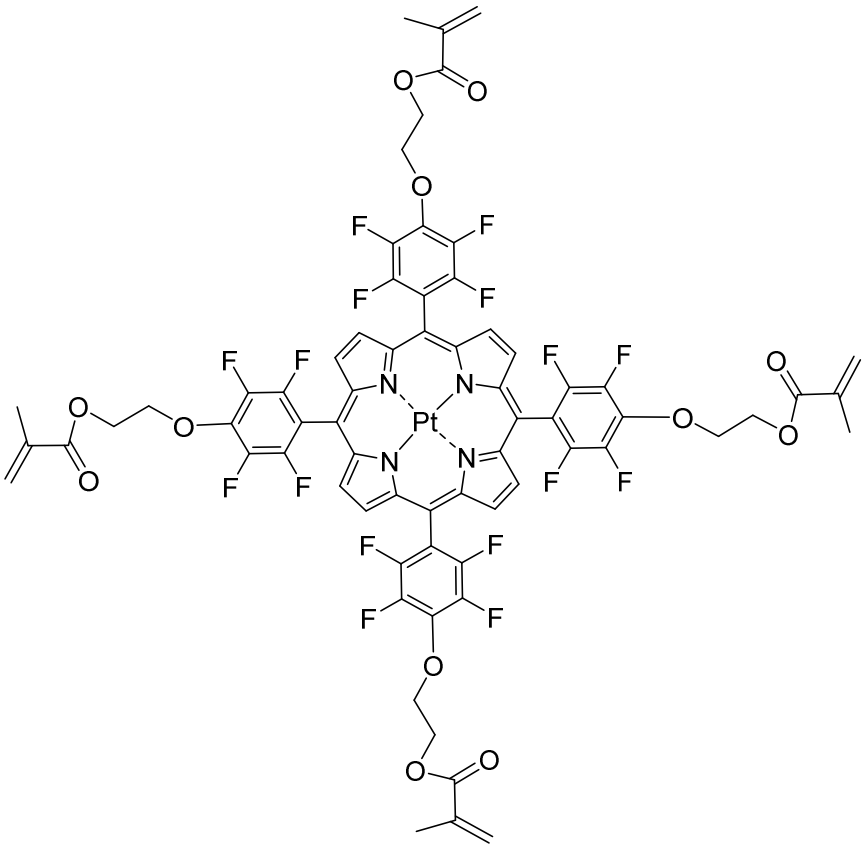


Fig. S7. (a) Microscopic images of HeLa cells grown on films with grating width at 5 μm (A, C) and 50 μm (B, D) under bright field (A, B) and 405 nm light excited fluorescent field (C, D).



Oxygen Probe (OS)

Fig. S8. The chemical structure of oxygen probe.

References

1. Y. Tian, B. R. Shumway and D. R. Meldrum, *Chem. Mater.*, 2010, **22**, 2069-2078.