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Supporting Information

Ultrathin Polymer Membranes with Patterned, Micrometric Pores for Organs-on-chips

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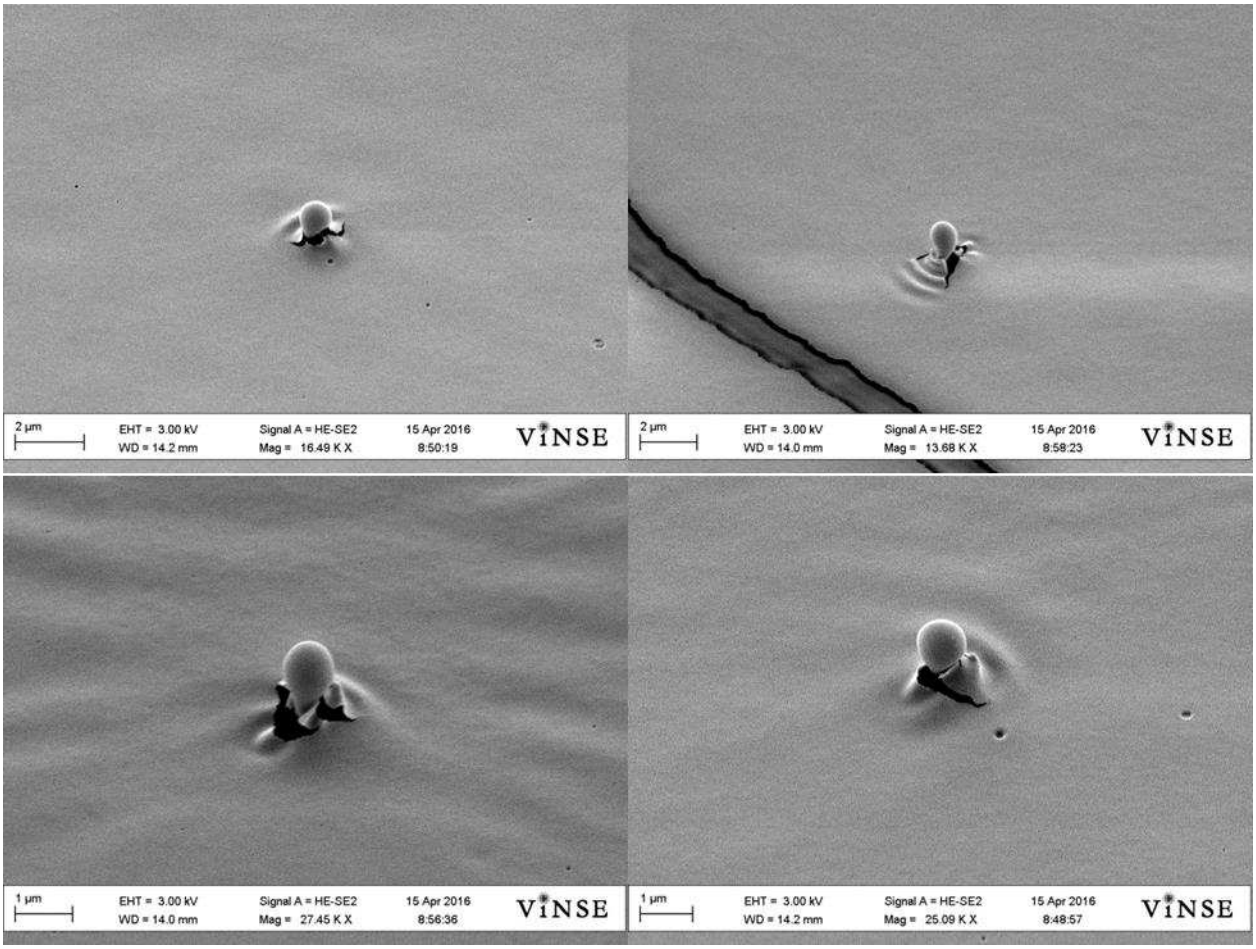

Figure S1: SEM images of PLLA coated PVA nanowires (Pt coated samples, 30° stage tilt)

Due to the high aspect ratio of the PVA needles and lack of wettability, the PLLA coating of the PVA tips is not homogeneous, with some needles not completely covered during the spin coating and some presenting a discontinuous coating from the base to the top of the needle. The liquid PLLA tends to accumulate at the tip of the needles, without damaging their structure and to dry on the top, forming a bulb structure. After the PVA is dissolved, these structures disappear, thus suggesting a discontinuity in the PLLA coating from the base to the top of the needle. Finally, based on SEM analysis of the PVA nanoneedles before and after PLLA spin coating deposition, the nanoneedles appear straight and not deformed by the deposition process or the centrifugal force.

Permeability of the PLLA nanofilms

Diffusion of FITC dextran (70 kDa molecular weight, Sigma Aldrich, USA) through the perforated PLLA membranes was measured by using a UV-Vis Spectrophotometer (Varian Cary 50, Agilent Technologies, Santa Clara, CA).

The experiment was performed in a 96-well plate. Five devices were assembled, following the protocols described in the Materials and Methods section, each one integrating one PLLA perforated membrane. FITC dextran solution (2 mg/mL in MilliQ water) was used to fill the upper chamber of the device, while the lower channels were filled with MilliQ water. Liquid from the lower channels was collected after 6 hours. One additional device was assembled with a PLLA membrane prepared with the same process parameters on a flat silicon wafer, which thus did not have holes and was not permeable.

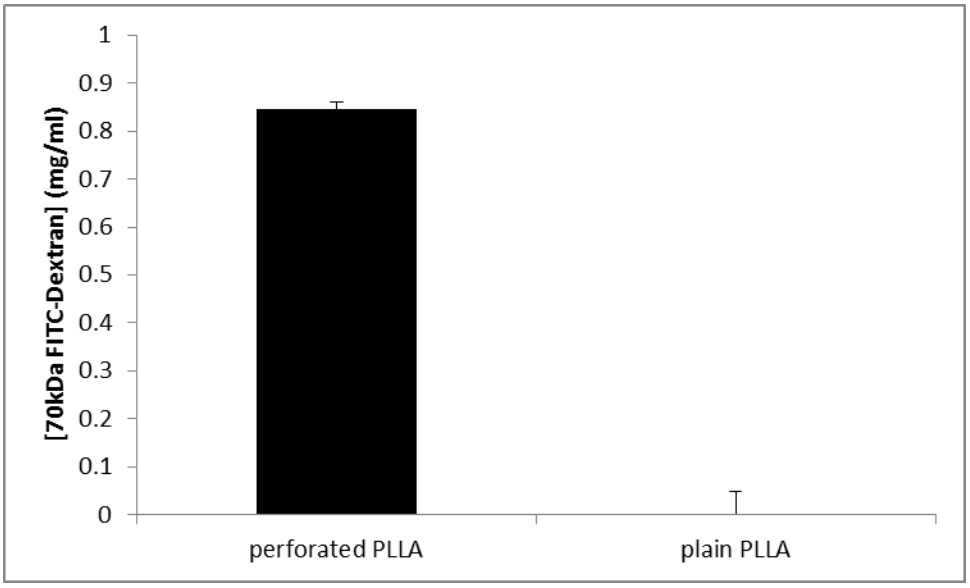

Figure S2: Permeability of PLLA membranes to FITC-dextran.

AFM thickness measurement

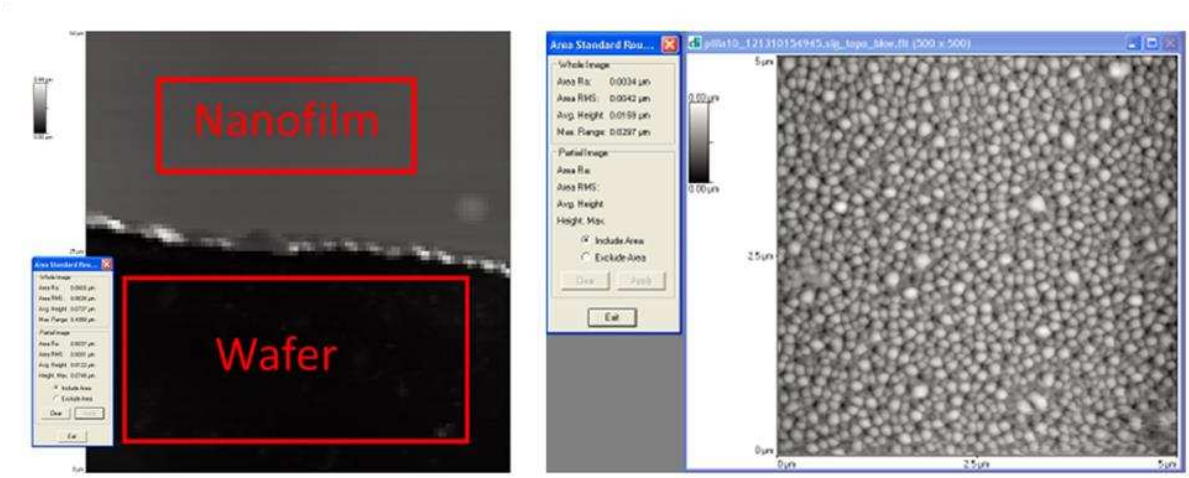

Fig. S3: AFM measurements. The 10 mg\mL PLLA nanofilm was released from the PVA replica, spread and dried onto a silicon wafer. Thickness (left) and roughness (right) of the film were measured and averaged on 3 samples. A Digital Instruments Nanoscan III AFM was used, operating in tapping mode in order to avoid artifacts and adhesion between the nanofilm and the tip (tip with elastic modulus of 20–80 Nm^{-1}, resonance frequency in the range of 235–317 kHz and average tip radius of 8 nm).

Thickness: 118.9 nm ± 2.7 nm (Samples Line: 128, Scan Rate: 0.3 Hz, Scan Range: 50 µm).

Roughness: Ra =3.4 nm, Rms=4.2 nm (Samples Line: 512, Scan Rate: 1 Hz, Scan Range: 5 µm).

Nanofilm mechanical properties

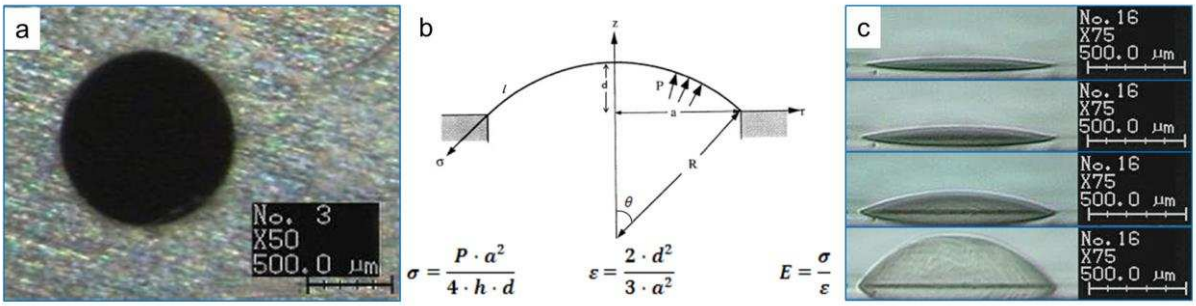

Figure S4: Bulge test measurements.

The nanofilm was released from the PVA layer and deposed on a stainless steel support (Fig. S4.a). The support has a hole (radius a=1 mm) machined by EDM. Hydrostatic pressure is applied through the hole to inflate the film (as schematically represented in Fig. S4.b). The deflection of the film is thus observed and measured by an optical microscope as shown in Fig. S4.c.

For the PLLA film with average thickness of 118.9 ± 2.7 nm, the resulting Young modulus is E=2.3 GPa± 0.6.

HUVECs culture in flask

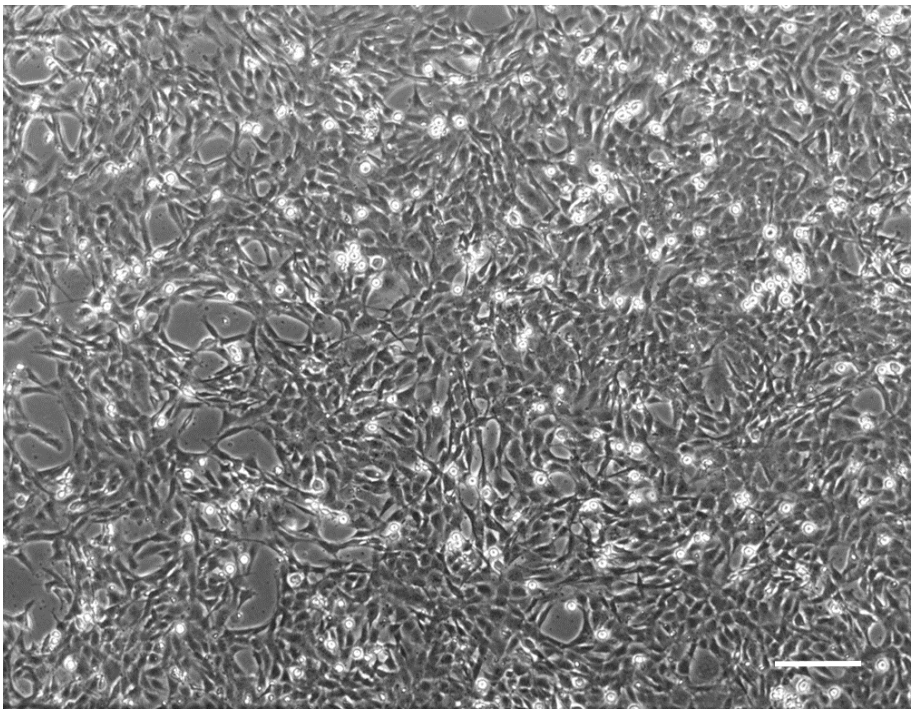

Figure S5: HUVECS culture inside a traditional polystyrene flask. Reported as control to be compared with same cells cultured inside the device, on the porous membrane (scale bar 200 μm).