Supplementary Information for

Contactless pressure detection enabled by a hybrid 3D laser-printed nanophotonic sensor

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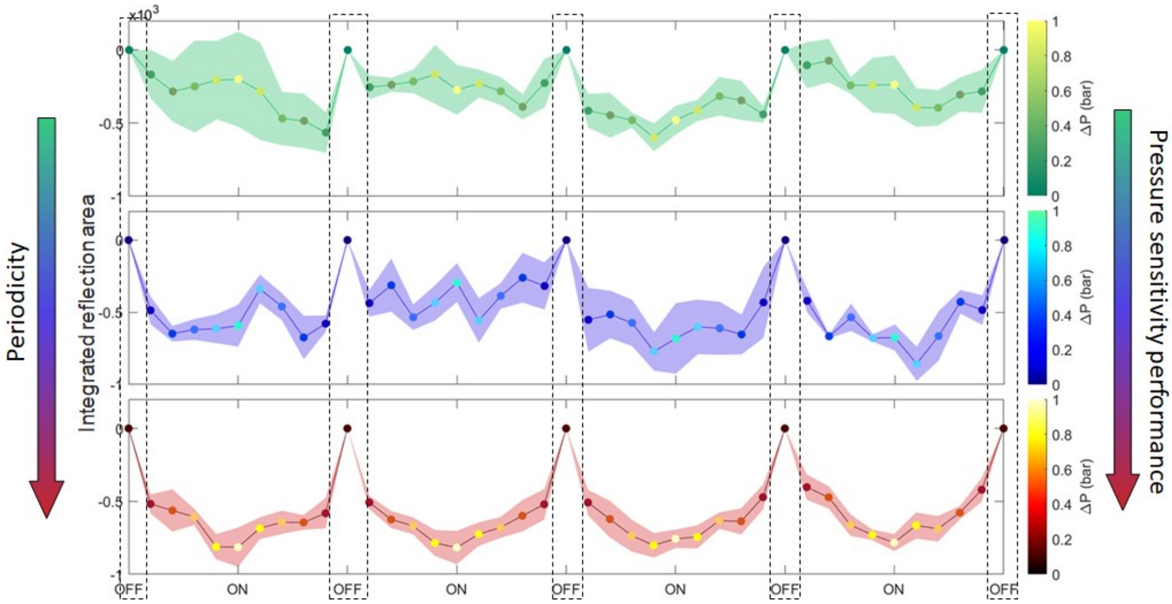
Supplementary text



S1 Continuous loading/pressure cycling

Fig. S1. Continuous loading/pressure cycle. (From top to bottom) Each row shows repetitions of 4 continuous pressure cycles for 1.9 (green), 2.1 (blue), 2.2 µm (red) periodicities. By increasing the periodicity, the pressure sensitivity performance increases. The dashed OFF boxes represent the "exhaust mode" of the bulge setup when no gas is inflating in the chamber.

To prove repeatability in pressure sensitivity of WDs structures, we perform a continuous loading cycle (Fig. S1). Exploiting the same sample, we apply four continuous pressure cycles from initial pressure ΔP=0 bar to final pressure ΔP=1 bar of 1.9 (green), 2.1 (blue), 2.2 μm (red) periodicities.

The reflection plots show an increase of pressure sensitivity as the periodicity increases. The increase of the minimum point (at the highest pressure values of ΔP= 1 bar) in 1.9 μm (green, Fig. S1 top) is absent from 2.1 (middle) and 2.2 μm (bottom) periodicities. The most symmetrical trends between inflection and deflection, and the largest reduction of reflection as well as smallest errors are for 2.2 μm periodicity.

S2 Pressure testing in fine steps.

While the aim of the current study is to investigate a wide range of set pressure (up to 1 bar), future investigations may focus on where we observe the highest contrast (between consecutive pressure steps) of optical properties for the current nanostructures. Here we evaluate the pressure sensitivity using fine steps (0.04 bar) of set pressure between 0-0.2 bar.

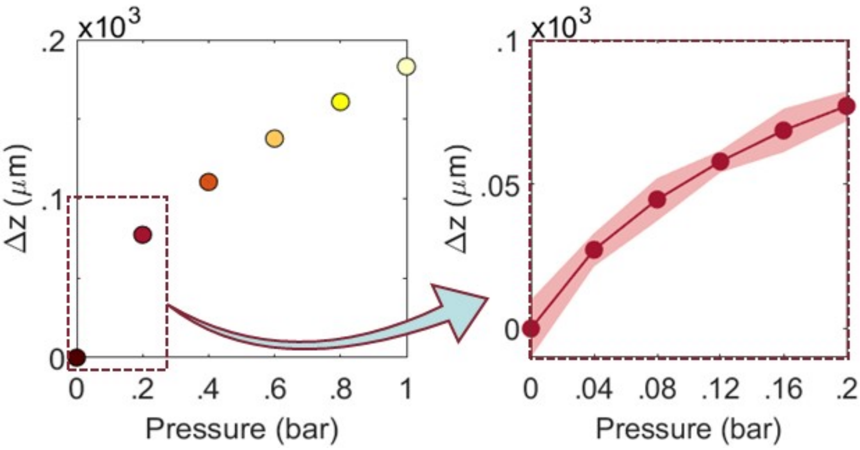


Fig. S2. Pressure testing with fine steps. (Left) Set pressure as a function of displacement of the membrane in z-axis. (Right) Pressure scan within the 0-0.2 bar range with steps of 0.04 bar.

S3 Mechanical aging of photonic structures after consecutive loading cycles.

To better understand why the pressure sensitivity is reduced after fatigue testing (Fig. 5), we recorded high-resolution SEM photos prior and after testing (1000 consecutive loading cycles). Prior testing, the structures show minor fabrication imperfections (left, Fig. S3) while after exhibiting localised cracks (right, Fig. S3). Here, our hypothesis is that fabrication imperfections acting as crack 'starting points'. Ideally, the applied global strain is developed uniformly on the structure. In contrast, fabrication imperfections acting as strain concentrators leading crack evolution around these points.

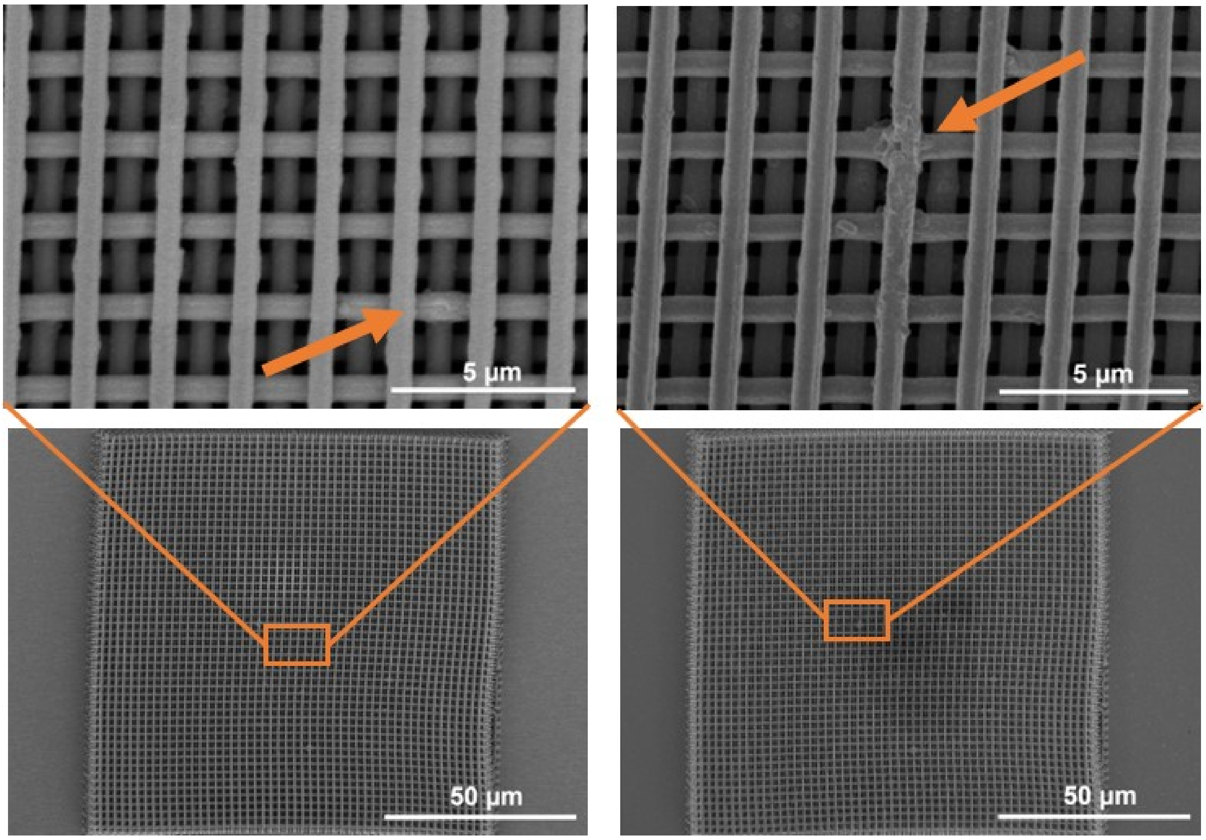


Fig. S3. Mechanical aging of photonic structures after consecutive loading cycles. SEM before (Left) and after (Right) consecutive mechanical loading.

S4 Photothermal heating management via thin layer deposition.

Below we show microscope images of direct laser writing (DLW) nanofabrication on substrates of different coatings and the reduced photothermal damage in each case. Briefly, Fig. S4 shows the photothermal heat management via thin layered substrates. This indicates that the Au/C layers on PI result in better DLW according to our photothermal simulation data in Fig. 2.

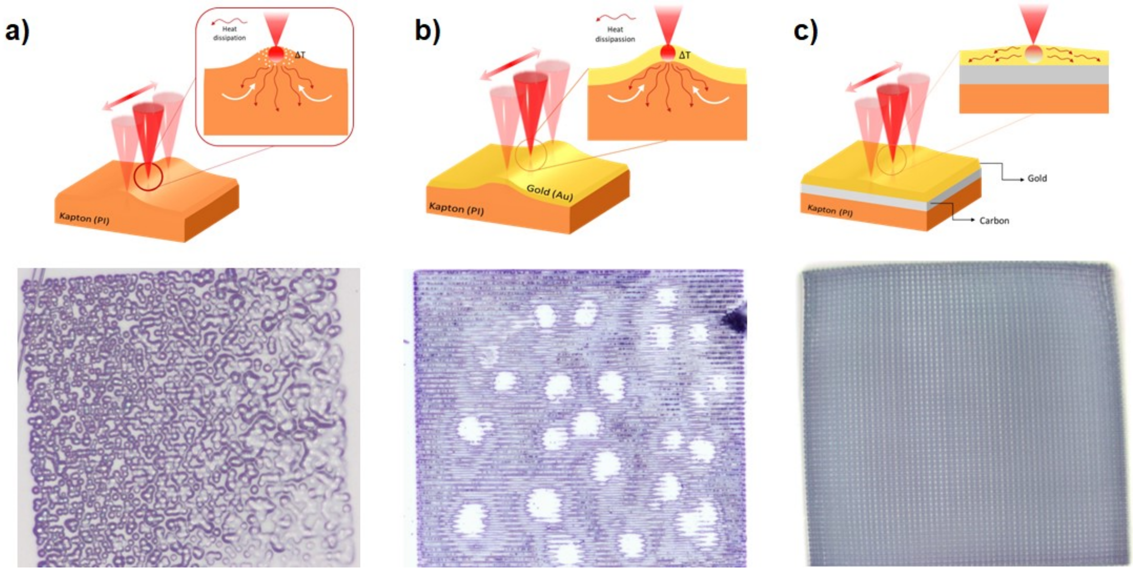


Figure S4: Photothermal heating management via thin layered substrates. Direct laser writing on **a)** polymeric (PI) **b)** Au film on PI and **c)** Au/C on PI. Here we show schematics (up) and microscope images of the resulting DLW (down).