Enhancement of hydrophobicity and biocompatibility in embedded pressure sensor through laser surface modification

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Organ-on-a-chip technology has emerged as a significant research topic in recent years [1]. It offers the ability to mimic the behavior of human organs ex vivo, obviating the need for animal experimentation. The monitoring of an organ's behavior and status necessitates various sensors to determine its conformity to the actual state of human organs. Typical sensors include those for pressure, flow rate, gas, etc. The kidney, a fragile organ, is particularly susceptible to damage from hypertension. Therefore, in the development of kidney-on-a-chip, it is crucial to accurately and continuously monitor the pressure state exerted on the kidney. However, in microfluidic systems, pressure sensors are often positioned externally to the chip. This indirect method of gauging the pressure within the channels is significantly imprecise due to the variances in parameters such as channel dimensions and the difference in liquid viscosity caused by biomaterials. To detect the true state in situ, embedded sensors are essential. In this study, we integrated piezoelectric sensors into the kidney-on-a-chip. A protective layer was deposited on the piezoelectric sensors to shield the electrodes and enhance their lifespan. This protective layer was endowed with nanostructures through 355 nm UV laser processing, rendering the sensor surface hydrophobic and biocompatible [2]. We analysed the laser processing parameters and the hydrophobicity to ensure precise pressure measurement without residue retention. Furthermore, biocompatibility tests (ISO 10993) were conducted to confirm that the sensor surface is non-toxic and does not interfere with biological processes. As illustrated in Figure 1, the developed in situ sensor can be embedded within the organ chip. Our objective is to precisely control the net glomerular pressure at 10 mmHg, thereby establishing a simulated ex vivo biological experiment system. We believe that such laser surface modification technology will contribute to the future development of various organ-on-a-chip systems.

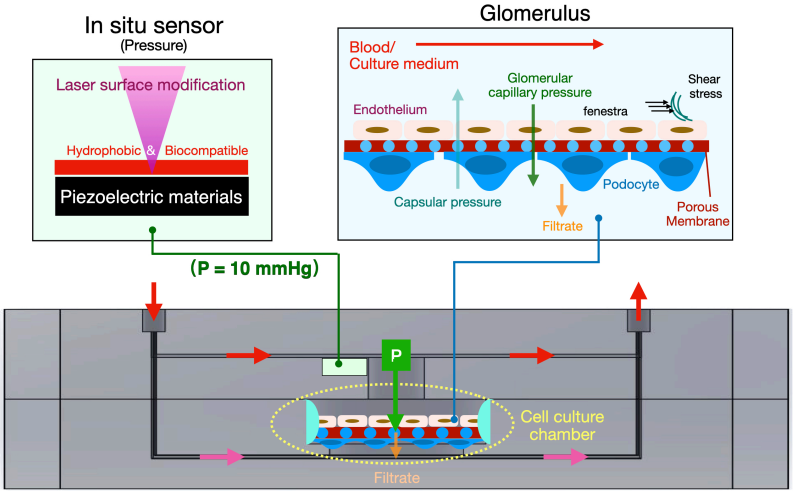

Fig. 1. In Situ Pressure Sensors Embedded within the Kidney-on-a-Chip

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