Electronic Supplementary Material (ESI) for Lab on a Chip

Supplementary Information (SI)

Parylene to silicon-nitride bonding for post-integration of high pressure microfluidics to CMOS devices

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Supplementary Figures

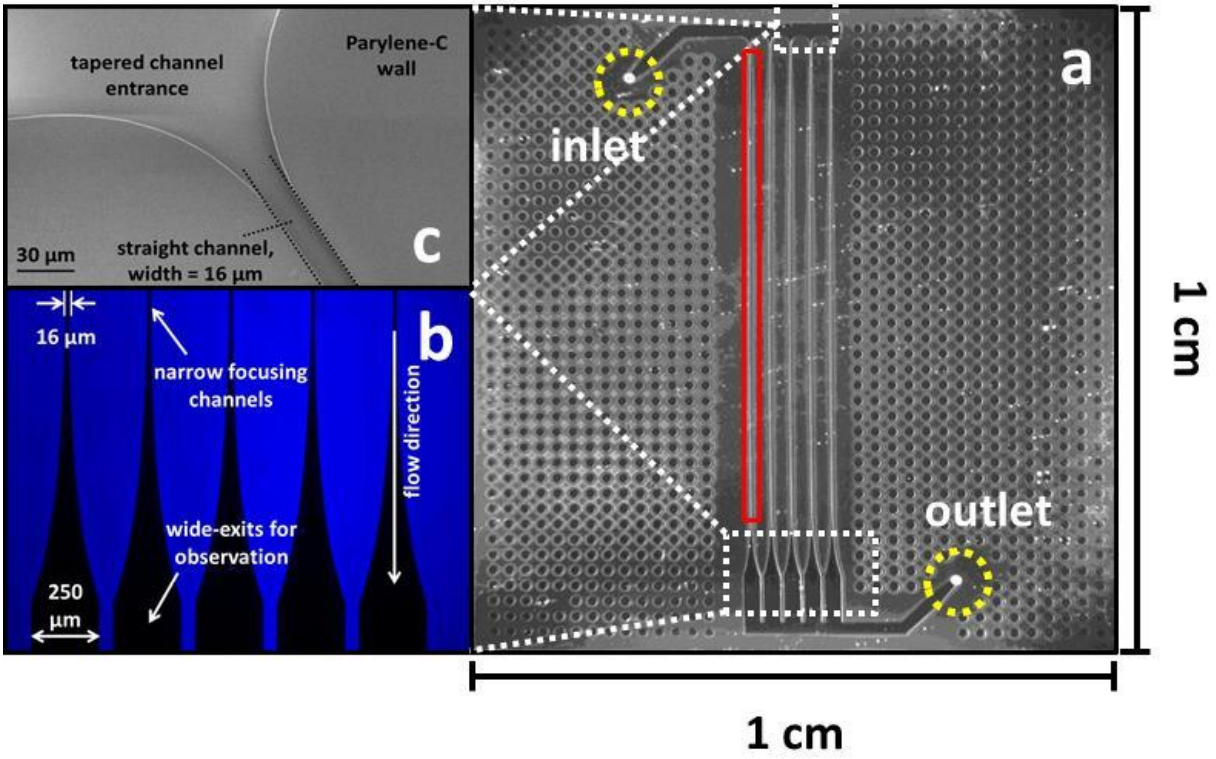

Fig. S1 Pictures of microfluidic devices (a) Bright field stereo-microscope image of the whole chip, indicating the functional parts. (b) Fluorescent image of the chip exit with corresponding dimensions (5x objective, UV excitation/Blue emission filter). (c) SEM image of the channel entrance region and a part of the straight channel, taken before bonding. In our case, the height of the channels is determined by the coated parylene-C thickness, which is chosen to be 10 µm.

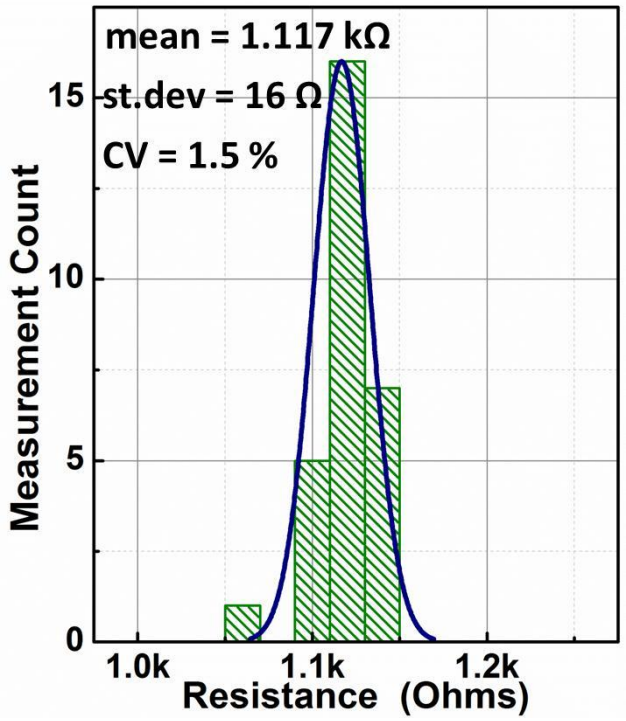

Fig. S2 Histogram of the DC resistance of the pad-to-pad test electrodes. The measurements were done with a DC multimeter after bonding and dicing of the device. These structures consist of 100 nm thick and 20 µm wide platinum electrodes having approximately 1.5 mm length and connected to a PCB via zebra connectors, as suggested by Fig. 2(c). The picture of the devices with electrodes used for these experiments is shown in Fig. 2(b).

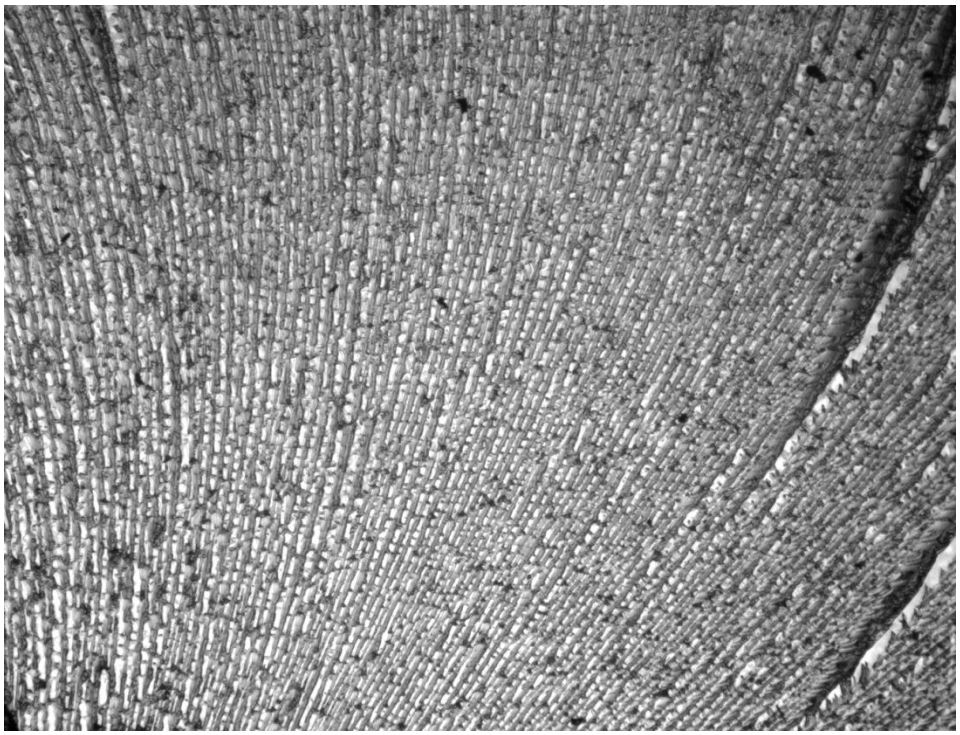

Fig. S3 Bright field image of a fractured interface taken with a 5X objective, showing the cracks that occurred in the bulk of the Parylene-C during the pull-tests.

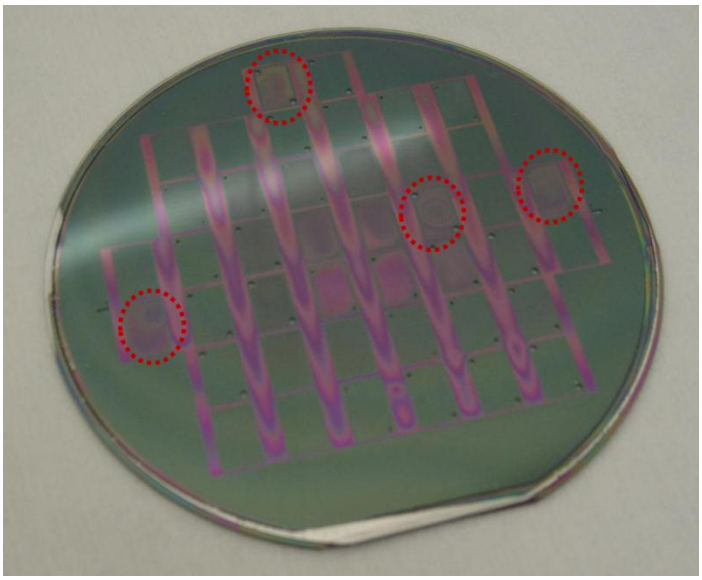

Fig. S4 Photograph of a 4-inch wafer bonded wafer. This design contains 42 microfluidic devices. Here, the regions with bonded Parylene-C appear green and the regions where the Parylene layer has been etched before bonding appear purple. The devices look different due to different designs containing varying percentages of etched structures. Also, inlet sizes range between 100 μm and 1000 mm. In this wafer, the red dotted circles show 4 devices that are not properly bonded, and the corresponding bonded device yield is 90%.

Table S1 - Comparison of bonding process parameters with respect to previously reported double layer Parylene-to-Parylene bonding.

Ref	Temp.	Duration	Tool Pressure	Bonding Env.	Bonding Equipment	Method	Comments
Kim et. al. [9]	230 °C	30 min	100 kPa	Vacuum	Commercial	Parylene-to-Parylene	Convection heating, 4-inch wafer
Noh et.al. [8]	160 °C (interface)	30 min	1.5 MPa	Air	Custom Made	Parylene-to-Parylene	Microwave Heating, 3-inch wafer
Ziegler et. al. [19]	160 °C	30 min	4.9 MPa	Air	Custom Made	Parylene-to-Parylene and delamination	Convection heating, 2-inch wafer
This Work	*280 °C*	*40min*	*100 kPa*	*Vacuum*	*Commercial (Suss SB6)*	*Parylene-to-Si_3N_4*	*Convection heating, 4-inch wafer*