Electronic Supplementary Material (ESI) for Lab on a Chip

Programmable parylene-C bonding layer fluorescence for storing information on microfluidic chips

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Supplementary Figures, Table and Text

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Supplementary Figures

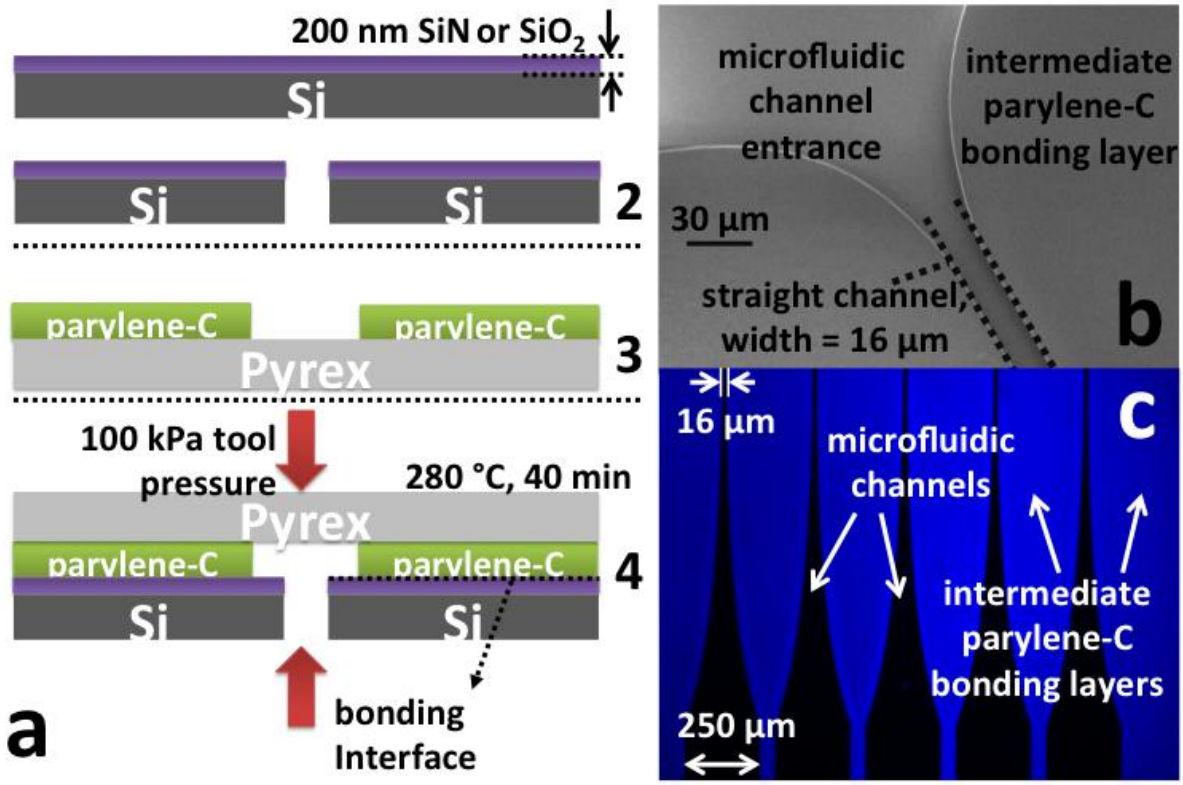

Fig. S1 Microfluidic devices fabricated using parylene-C to SiN (or SiO_2) bonding. **(a)** Illustration of the fabrication process. 1) Si wafers with 200 nm thick SiN were taken. 2) Fluidic inlet holes were opened in one silicon wafer by Deep RIE. 3) Channels were etched in a 10 µm thick parylene-C using RIE via an aSi mask. 4) Wafers are bonded at 280 °C under vacuum during 40 minutes while applying 1000 mbar tool pressure. **(b)** Shows a scanning electron microscope (SEM) image of parylene-C just before bonding, where the etched trenches correspond to microfluidic channels and parylene-C acts as an intermediate bonding layer in a subsequent bonding process. **(c)** Fluorescent image of a bonded device observed with UV excitation (310 – 390 nm)/Blue emission (420 nm -) filters, where the dark and fluorescent regions correspond to microfluidic channels and intermediate parylene-C bonding layer fluorescence (iPBLF) respectively.

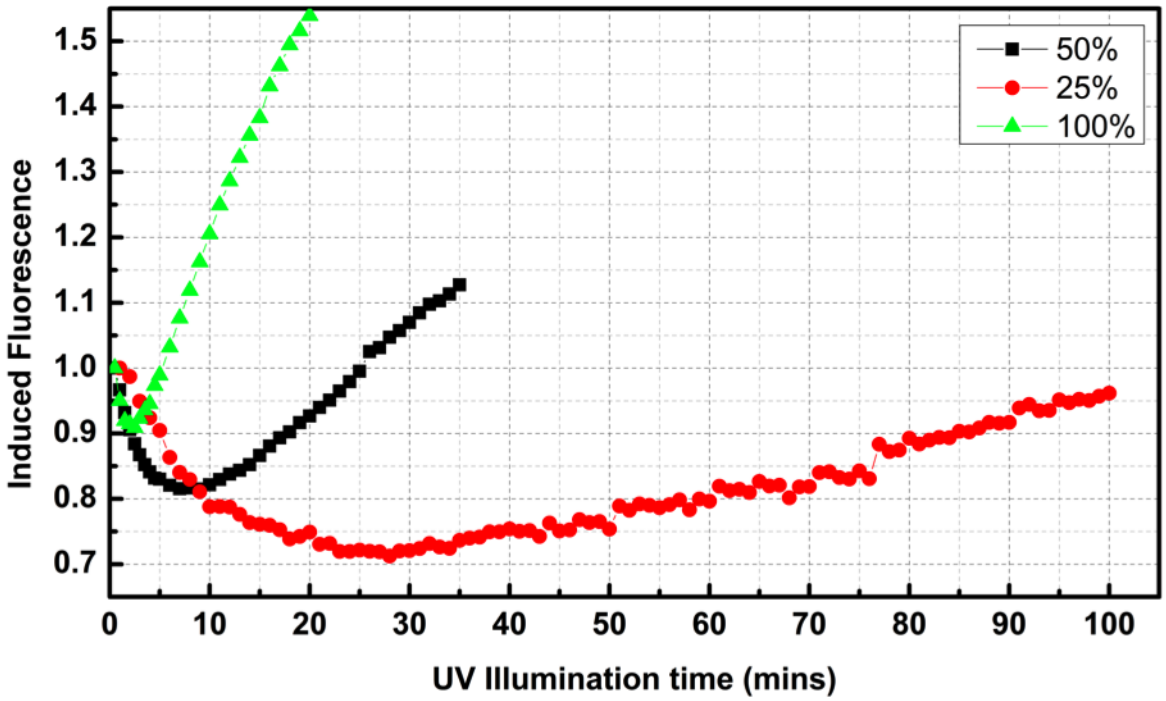

Fig. S2 Induced fluorescence F_{ind} versus the illumination duration under UV illumination using different intensity filters which pass 100%, 50% and 25% of the light, respectively. During initial exposure, we have observed an exponential decay bleaching behavior in the UV/Blue channel for all intensities. For 100% UV illumination intensity, an increase in the fluorescent signal is observed after a few minutes. On the other hand, with lower UV illumination intensity, bleaching remains dominant and recovery of initial fluorescence cannot be achieved. We can conclude that the formation of C=C bonds and development of the associated fluorescence is dominant, only if there is enough illumination power provided.

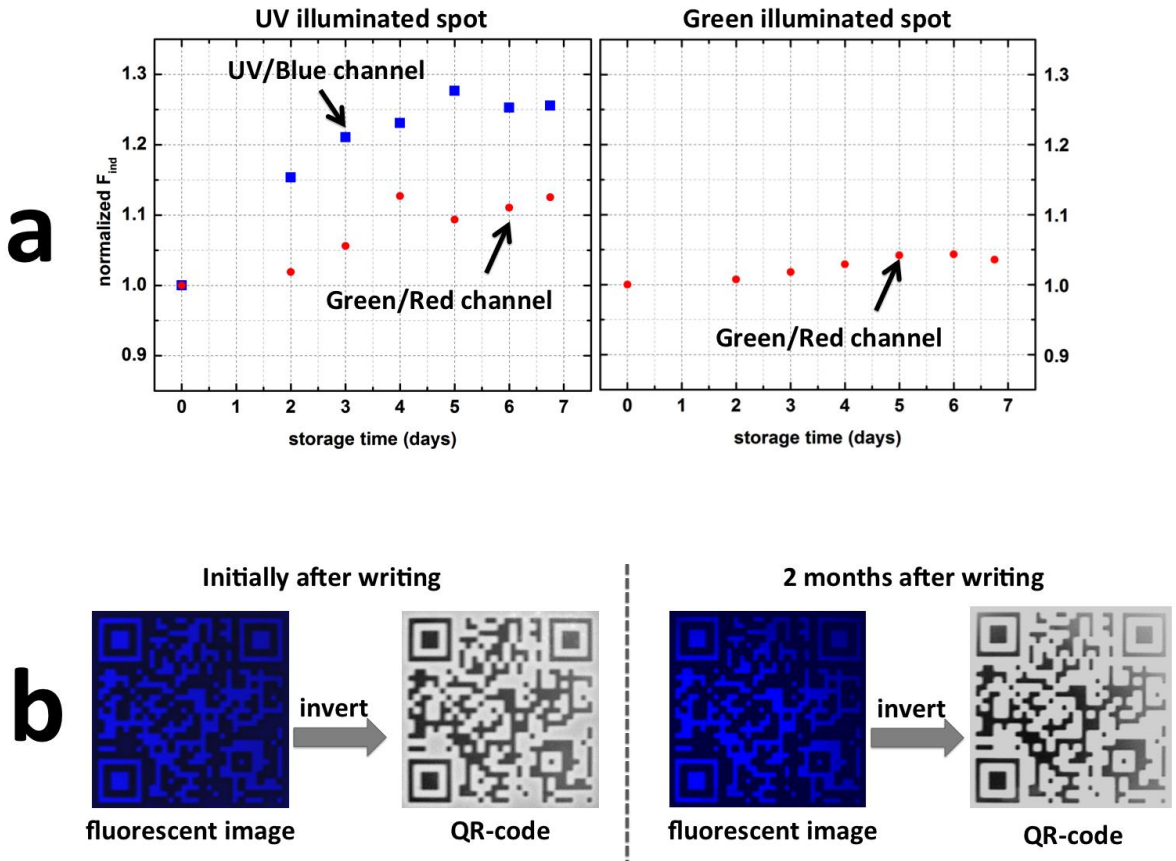

Fig. S3 Stability of the induced fluorescence F_{ind}. **(a)** The study of the induced fluorescence written by UV illumination and written (bleached) by Green illumination over 7 days. We observe an increase of the induced fluorescence F_{ind} after UV illumination in both UV/Blue and Green/Red channels, when normalized to F_{ind} obtained right after the spot writing. For the spots written (by bleaching) using Green illumination and observed in the Green/Red channel, we find that F_{ind} has increased about 5% over one week. **(b)** Stability of the QR-code 2 months after writing. After initial code writing, we stored the chip at room temperature without any special protection from atmosphere and humidity for 2 months and later once again acquired the fluorescent image of the code. We have observed no difference in the resulting image and the code was easily recognizable by the software. The width of the fluorescent QR-code is 500 μm.

Supplementary Text

Estimation of irradiance received by sample

The efficiency of the microscope optical system (in percentage) over the excitation bandwidth when using a particular filter set can be estimated using the Interactive Fluorescent Dye and Filter Database of the microscope vendor Zeiss [S1]; their previously measured irradiance values at the objective backplane [S2] can be used to estimate the irradiation on the sample. This database allows us to estimate the mercury lamp spectrum (HBO50/103), the objective transmittance and the efficiency of the used filter-cube. The irradiance estimations are tabulated in Table S1.

[S1] Zeiss Interactive Fluorescent Dye and Filter Database. https://www.micro-shop.zeiss.com/us/us_en/spektral.php

[S2] Zeiss Microscopy Online Campus, Education in Microscopy and Digital Imaging, Light Source Powers. http://zeiss-campus.magnet.fsu.edu/articles/lightsources/ powertable.html

Table S1 The irradiance received by the sample when applying the filter sets for the fluorescence experiments when using a 20x objective.

Filter set (ex/em color)	**Excitation filter (nm)**	**Reported irradiance at backplane (mW cm^{-2}) [S2]**	**Optical transmittance of objective at given wavelengths [S1]**	**Irradiance at sample after objective (mW cm^{-2})**	
UV/Blue	BP 310-390	23.0	0.65	485	*Direct Measurement*
Blue/Green	BP 450-490	32.8	0.85	904	*Estimated*
Green/Red	BP 537-562	43.1	0.85	1188	*Estimated*
Yellow/Deep Red	BP 575-600	80.9	0.85	2231	*Estimated*
Red/Near IR	BP 625-655	9.1	0.85	251	*Estimated*
Deep red/IR	BP 670-700	-	-	-	-