Electronic Supplementary Material (ESI) for RSC Advances.

On-chip electrical detection of parallel loop-mediated isothermal amplification with DG-BioFETs for the detection of foodborne bacterial pathogens

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Abstract

In this supplementary section, we present figures with information that is complementary to the results presented in the main paper. Here, we show schematics and photographs that further describe our sensors and the testing setup to facilitate the explanation of the sensing mechanisms and necessity of new droplet biasing methods. We also show detailed plots of experiments that are only summarized in the results of the main text. These supplementary figures show multiple maps of drain current as a function of the biasing conditions, independent drain current histograms that show the ability to do parallel pH detection, and the full array of accepted and rejected sensors with the resolution metric described in the paper. In addition, the supplementary information also shows off-chip confirmation of the detection assays that are used on-chip and the parallel detection of *E.coli* (complementing the detection of *S.typhi* reported in the main paper) to test the specificity of the detection protocols.

Supplementary Figures

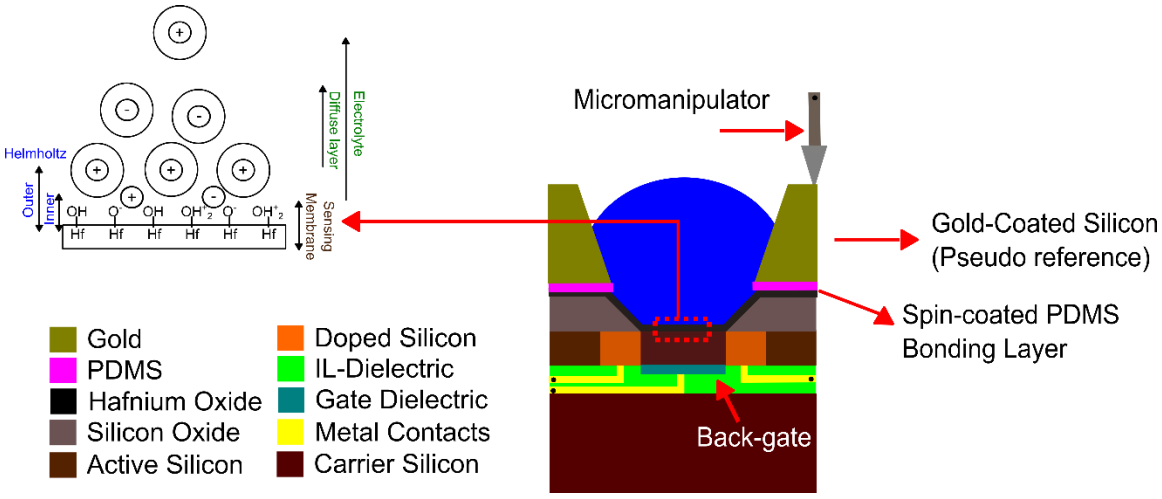

Fig. S1 Cross-section schematic of a DG-BioFET sensor and Helmholtz layers in the HfO_2 and electrolyte interface.

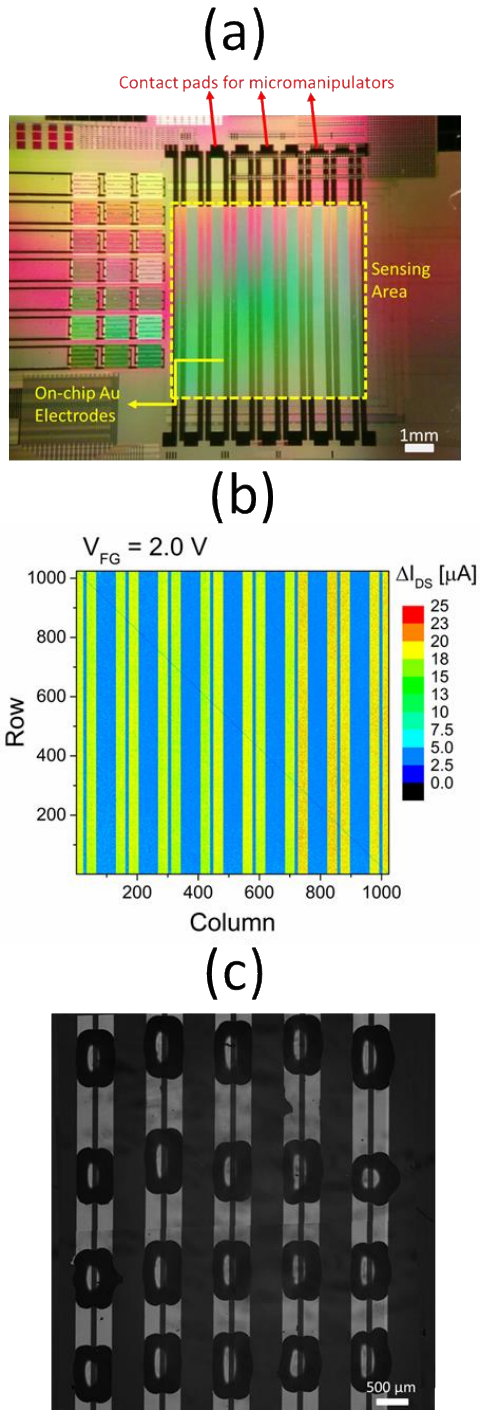

Fig. S2 On-chip reference electrodes for micro-droplet biasing. **(a)** Micro photograph of the DG-BioFET array with vertical on-chip gold electrodes. **(b)** 100 nL reaction droplets on the electrodes. The hydrophilicity ratios between metal and oxide confine the droplet between electrodes minimizing the sensing area exposed to the electrolyte. **(c)** I_{DS} heat map for chip with on-chip electrodes. The lift-off process affects the HfO_2 reducing the device fluid-gate trans conductance and diminishing the pH response.

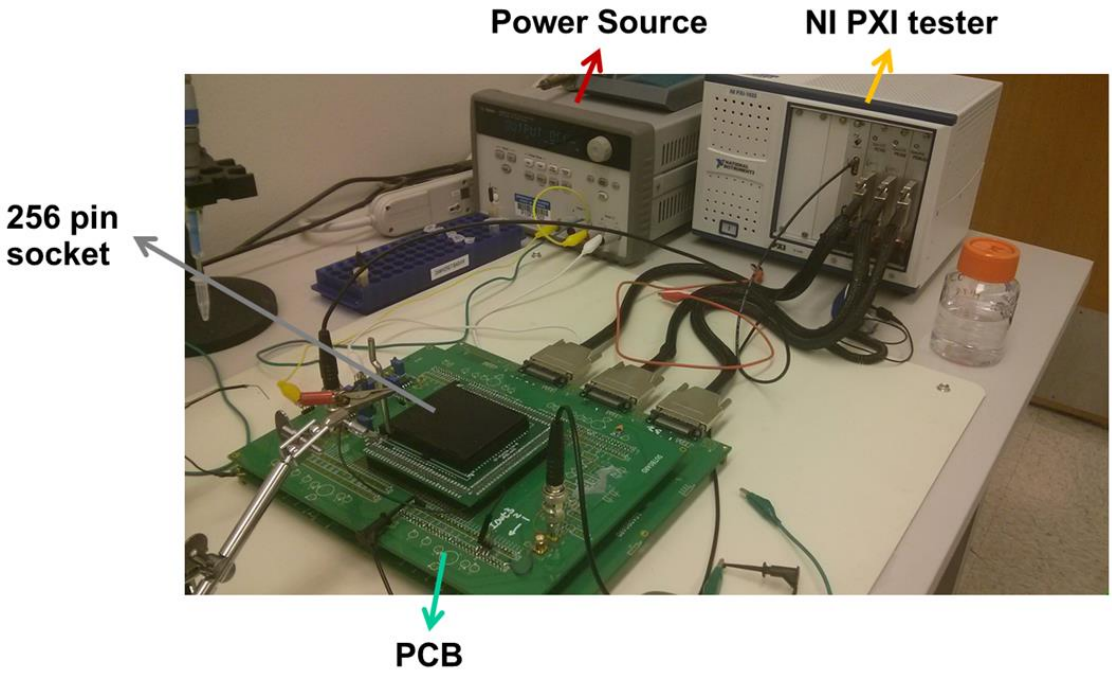

Fig. S3 Photograph of testing setup pointing the PXI IC tester card, PCB to route electrical signals, and the computer that runs the C++ scripts to collect data.

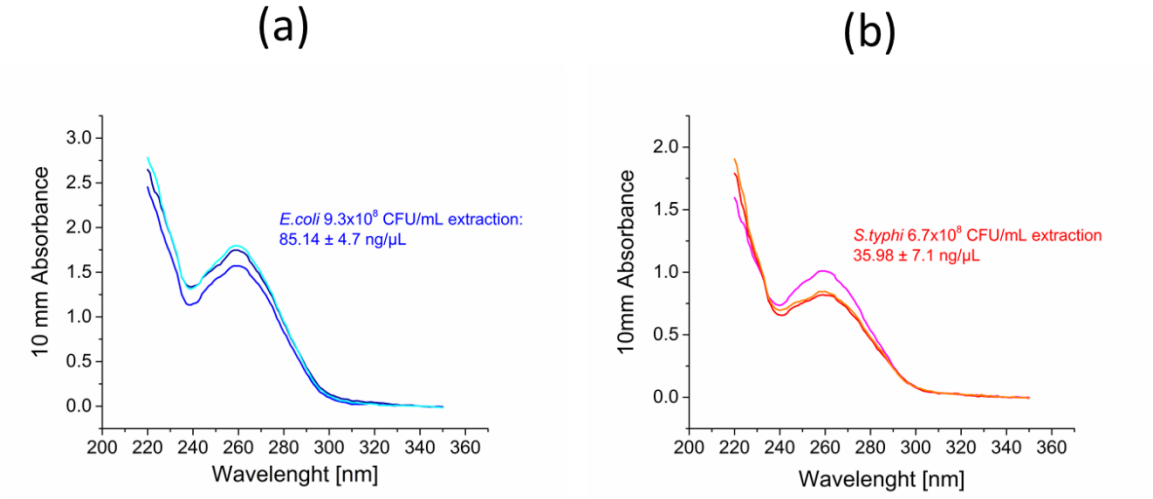

Fig. S4 Spectrophotometer absorbance of extracted DNA in water with the heat lysis extraction protocol for **(a)** *E.coli* O157 culture of 9.13 x 10^8 CFU/mL and **(b)** *S.typhi* culture of 6.7 x 10^8 CFU/mL.

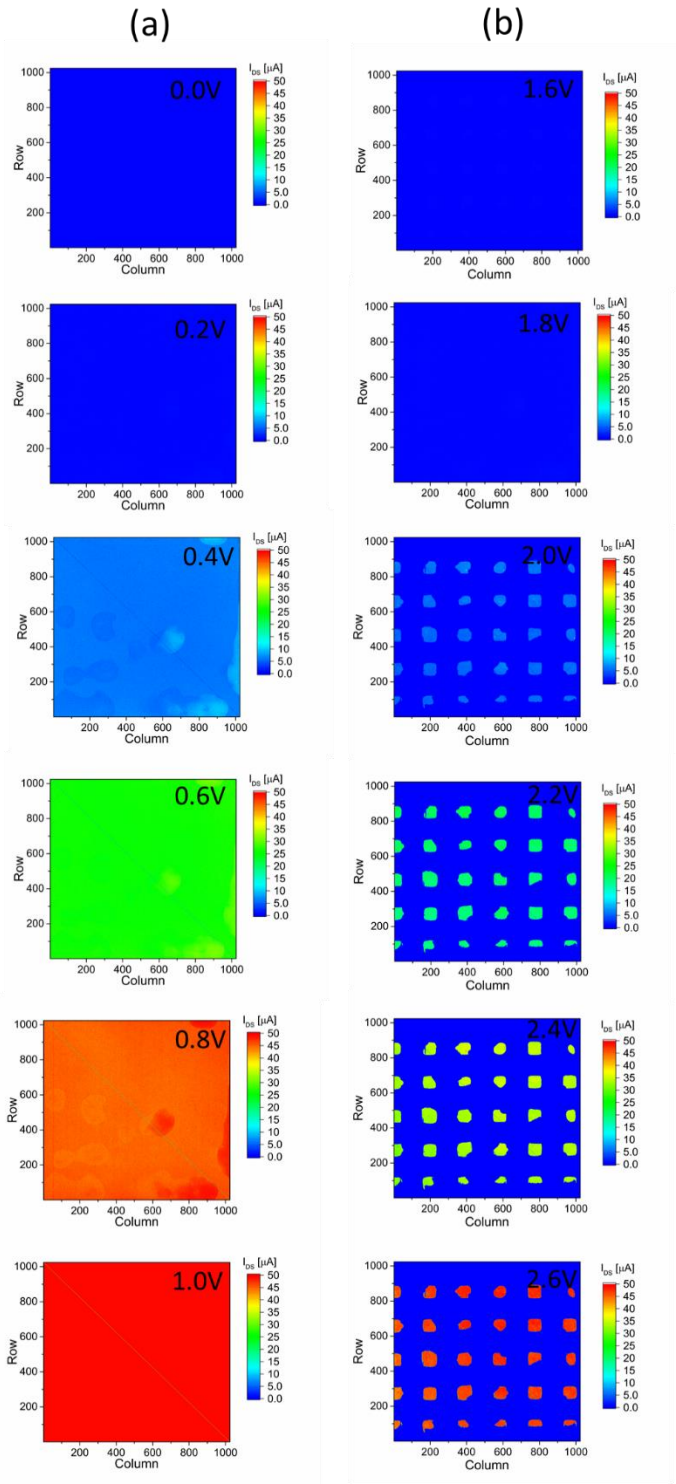

Fig. S5 Full color-coded drain current maps as a function of the biasing conditions. **(a)** Current maps as a function of the back-gate potential. **(b)** Current maps as a function of the fluid-gate potential applied with the gold pseudo-reference electrode.

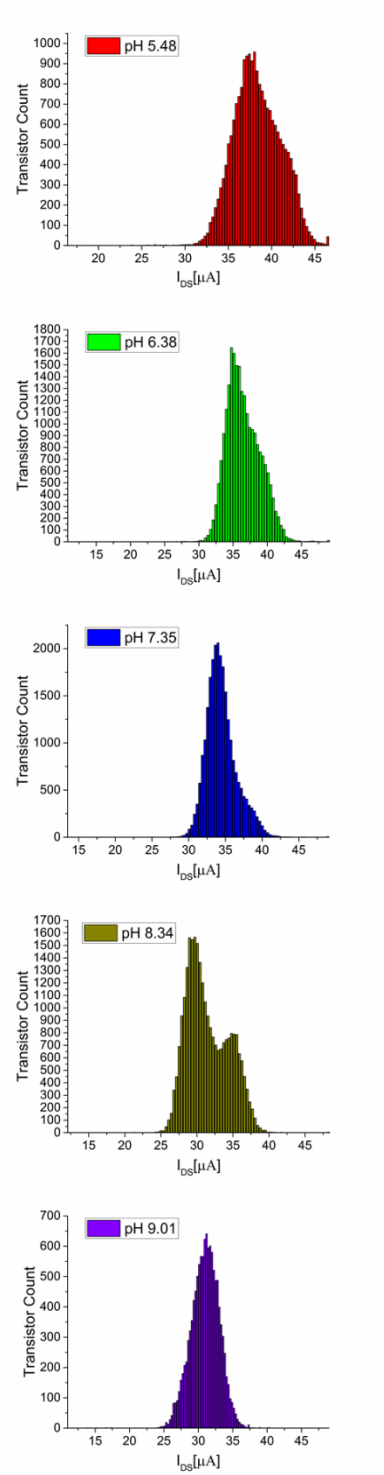

Fig. S6 Histograms of drain current for groups of reaction chambers with electrolyte of the same pH.

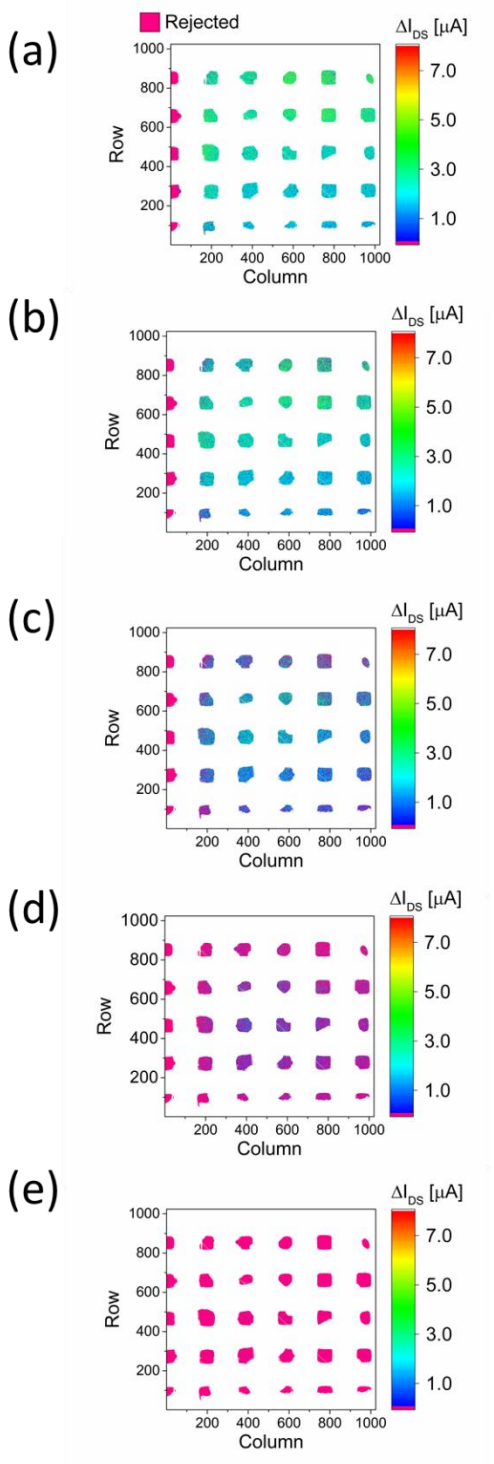

Fig. S7 Rejection of pixels with the resolution filter for a threshold of **(a)** 0.5, **(b)** 0.4, **(c)** 0.3, **(d)** 0.2, **(e)** 0.1.

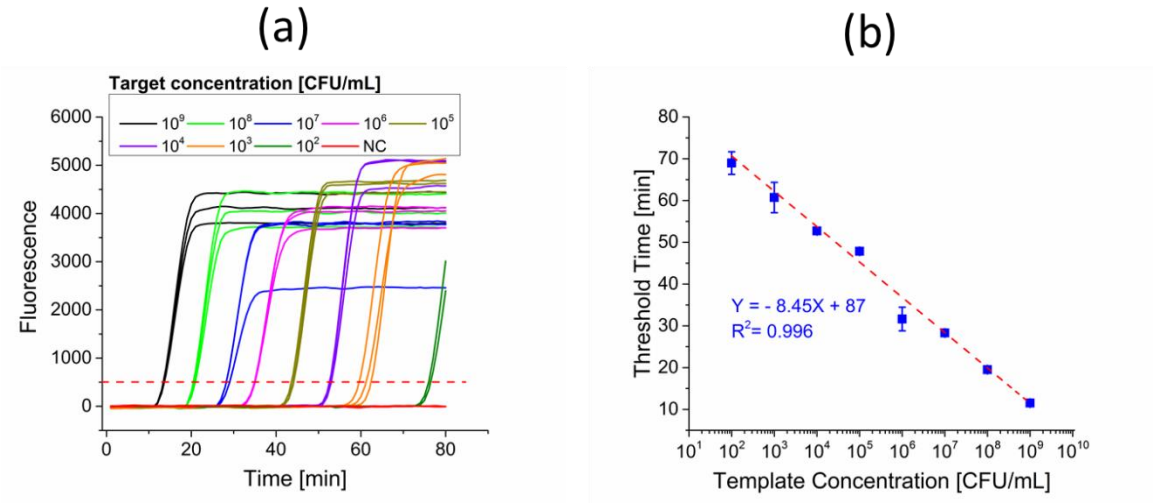

Fig. S8 Off-chip confirmation of the LAMP assay amplifying the eae gene from *E.coli* O157. Serial logarithmic dilutions and negative controls show the expected trends in amplification and specificity. **(a)** Real-time fluorescence monitoring of the reaction. **(b)** Standard curve for the reaction.

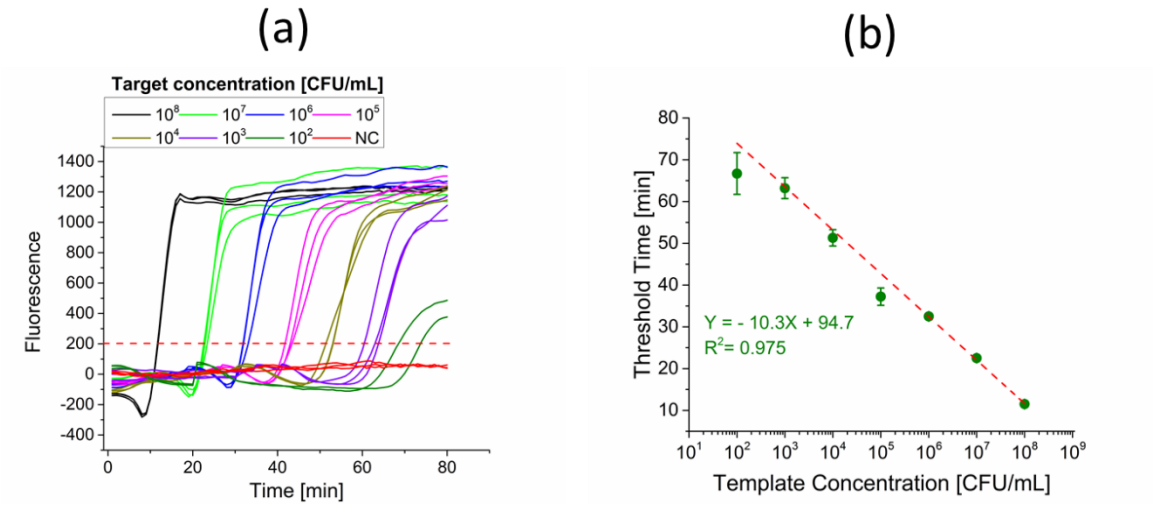

Fig. S9 Off-chip confirmation of the LAMP assay amplifying the invA gene from *S.tiphy*. Serial logarithmic dilutions and negative controls show the expected trends in amplification and specificity. **(a)** Real-time fluorescence monitoring of the reaction. **(b)** Standard curve for the reaction.

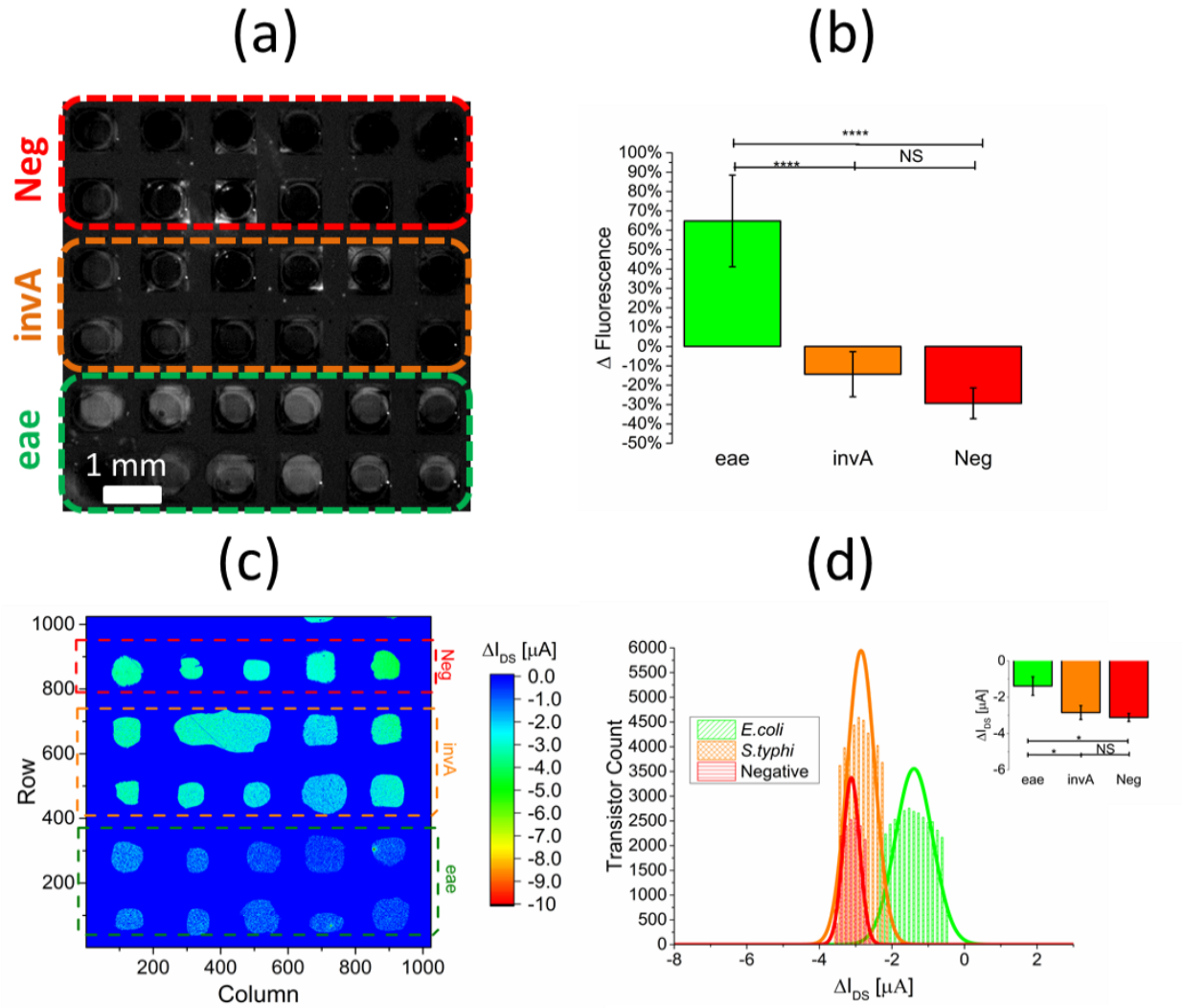

Fig. S10 Parallel detection of foodborne pathogens in DG-BioFET array chip targeting *E.coli* O157. **(a)** Fluorescence analysis of amplification and description of dried primers in chambers. **(b)** Quantification of fluorescence increments. **(c)** Differential drain current map and groups of chambers with dried primers. **(d)** Filtered differential drain current distributions.