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Supporting Materials

Paper Title: Investigation of Electrocatalysis for Tiered-Tower Micro-Electro-Mechanical-Systems

Biosensors: Applied to Early Prevention of Thrombosis Factor Trimethylamine N-Oxide

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Table S1. The parameter lists of improved Cole-Cole model and extraction results in solution of pH 7.0 and pH 4.0. α is a dispersion coefficient evaluating the relaxation time constants in an analyte.

Parameters in Figure 1D	pH 7.2	pH 4.0	Erythrocytes	Leukocytes	Plasma
R_catalyzed	350 Ω	182 Ω	627 Ω 675 Ω 715 Ω	450 Ω 475 Ω 460 Ω	431Ω 496 Ω 460 Ω
C_catalyzed	30 nF	35 nF	22 nF 25 nF 24 nF	24 nF 21 nF 22 nF	24 nF 22 nF 25 nF
Rp_catalyzed	550 KΩ	880 KΩ	140 KΩ 120 KΩ 130 KΩ	358 KΩ 341 KΩ 332 KΩ	261 KΩ 275 KΩ 256 KΩ
C_solution	3 nF	3 nF	3 nF	3 nF	3 nF
C_enzyme	25 nF	25 nF	25 nF	25 nF	25 nF

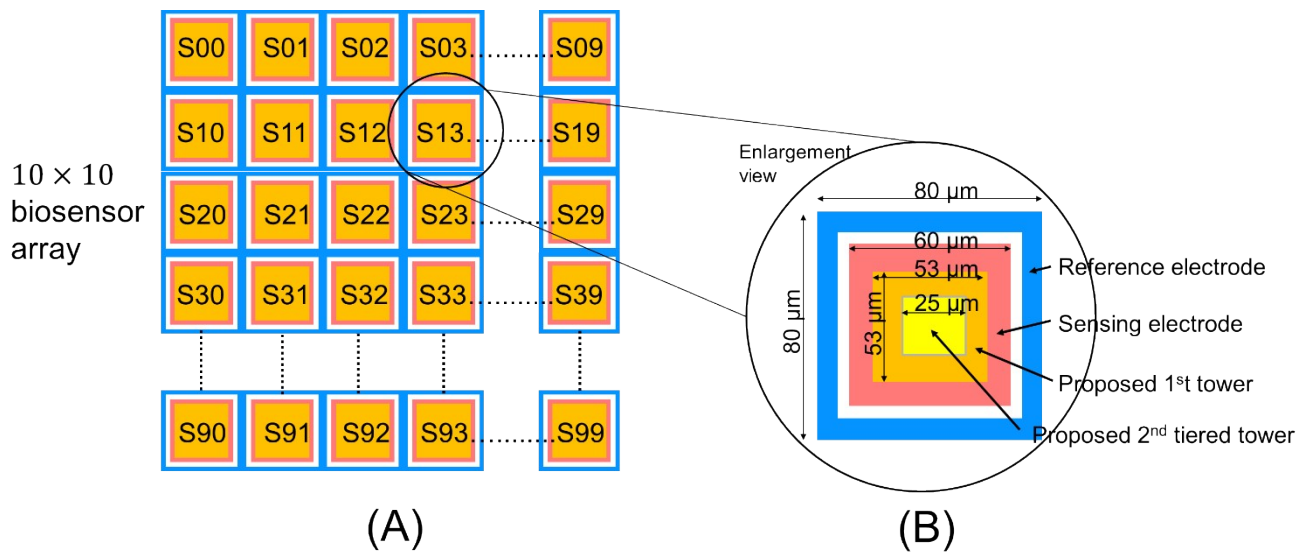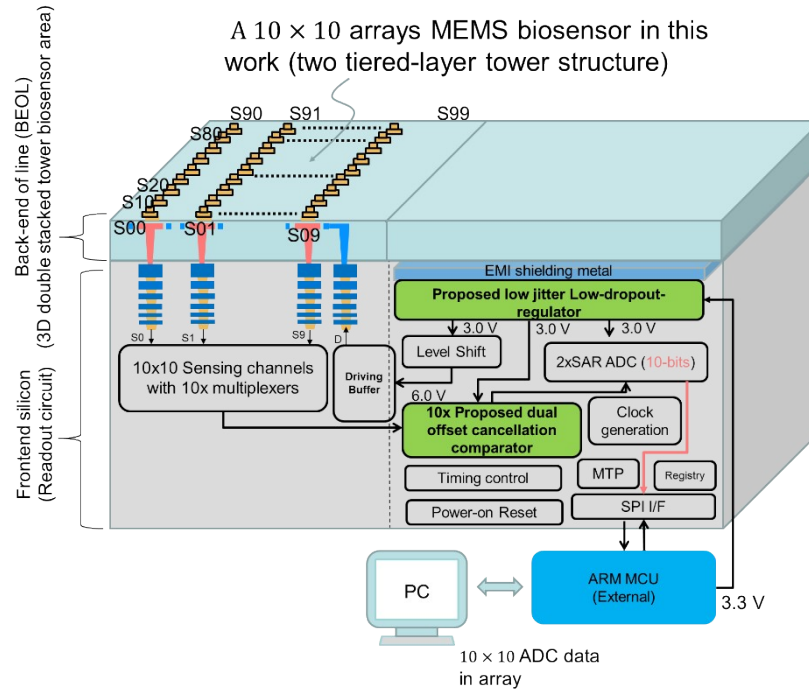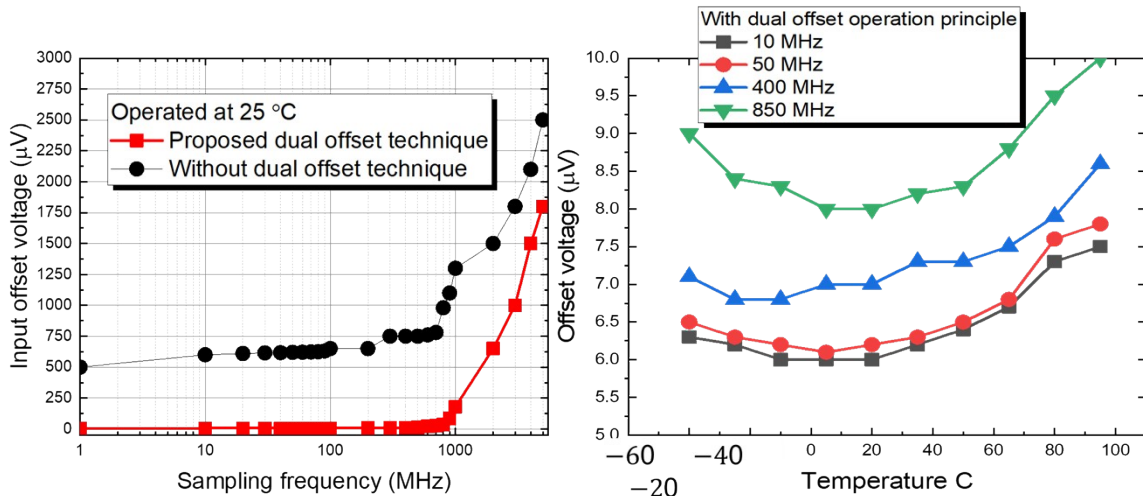**Figure S1.** (A) The arrangement of the proposed biosensor pixels, and (B) the critical dimensions for each tiered layer in a pixel.

Figure S2. (A) The system architecture of the proposed MEMS biosensor array and readout circuit. The readout circuit includes a low-dropout (LDO) regulator, a dual offset cancellation comparator, and a 10-bit ADC. (B) The measured result of input offset voltage for the dual offset cancellation comparator in the readout circuit. (C) The low offset voltage against temperature in the readout circuit.
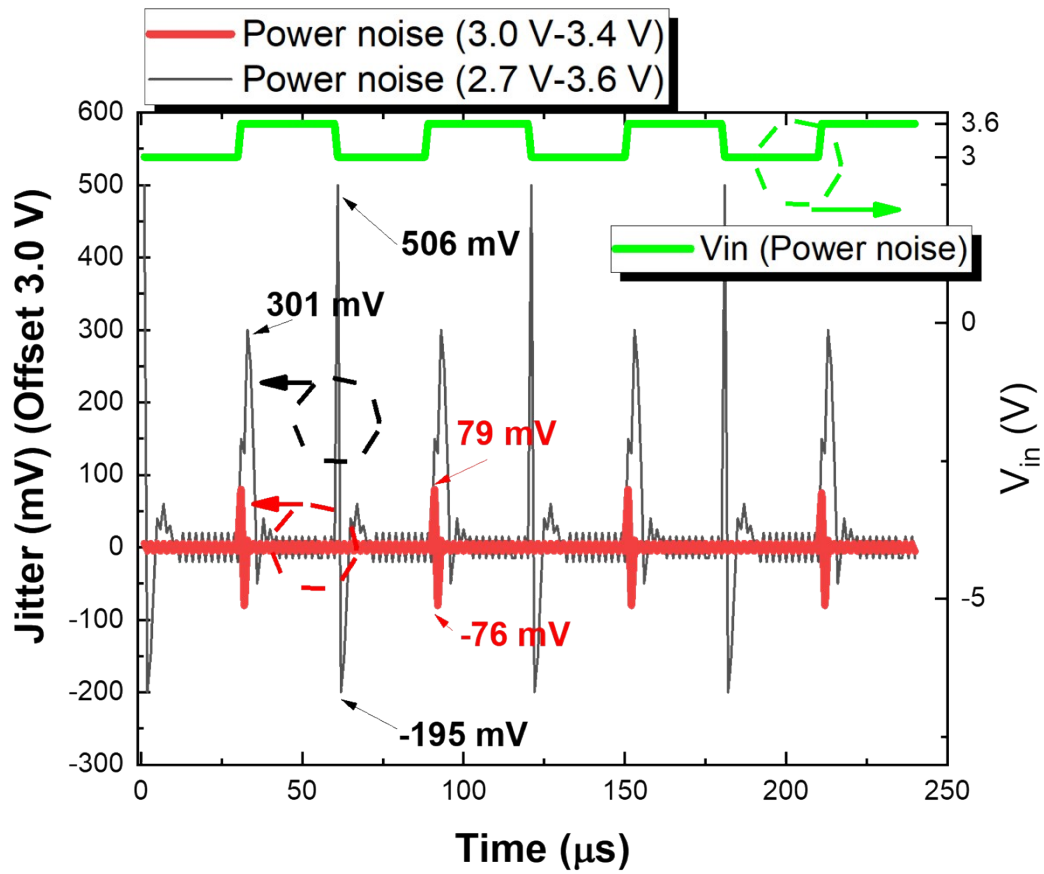
Figure S3. The measurement of output jitter from node V_MB of the proposed low-jitter low-dropout regulator shows the jitter offset by 3.0V. The jitters are investigated under power noise variations from 3.0V to 3.4V and from 2.7V to 3.6V.
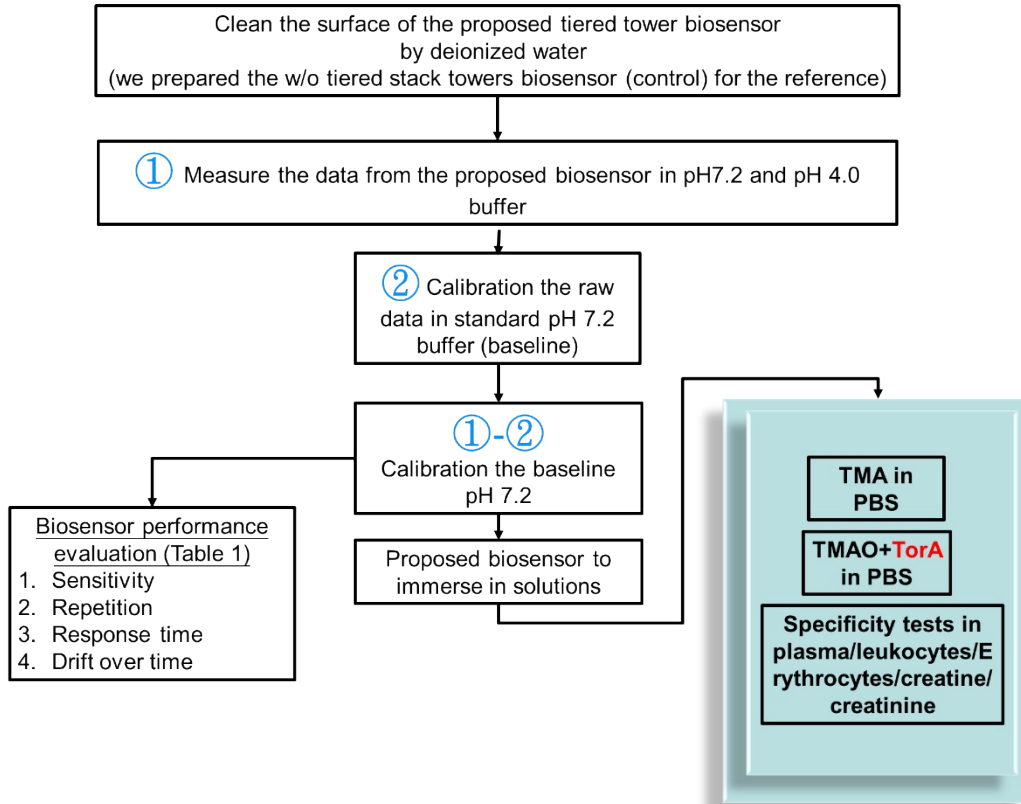
Figure S4. Measurement and calibration setup for TMAO with enzyme TorA begins with baseline calibration using pH 7.2 buffer. Subsequently, the proposed biosensor's performance is evaluated for sensitivity, repeatability, response time, and drift. Finally, specificity tests are conducted on plasma, erythrocytes, leukocytes, as well as creatine and creatinine.