Electrochemical piezoelectric-excited millimeter-sized cantilever (ePEMC) for simultaneous dual transduction biosensing

[SUPPLEMENTARY MATERIALS]

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These supplementary materials show photographs comparing the ePEMC sensor and flow cell with an EQCM. We also provide comparison of equivalent circuit models useful for examining ePEMC EIS response. Figures S.1 and S.2 compare the sensors, and Figure S.3 compares the flow cells. Figure S.4 shows the EIS spectrum of a representative ePEMC prior to biosensing with the fits of three equivalent circuit models that facilitate calculation of the charge transfer resistance parameter (R_{CT}) used to transduce molecular binding in the electrochemical sensing modality of ePEMC.

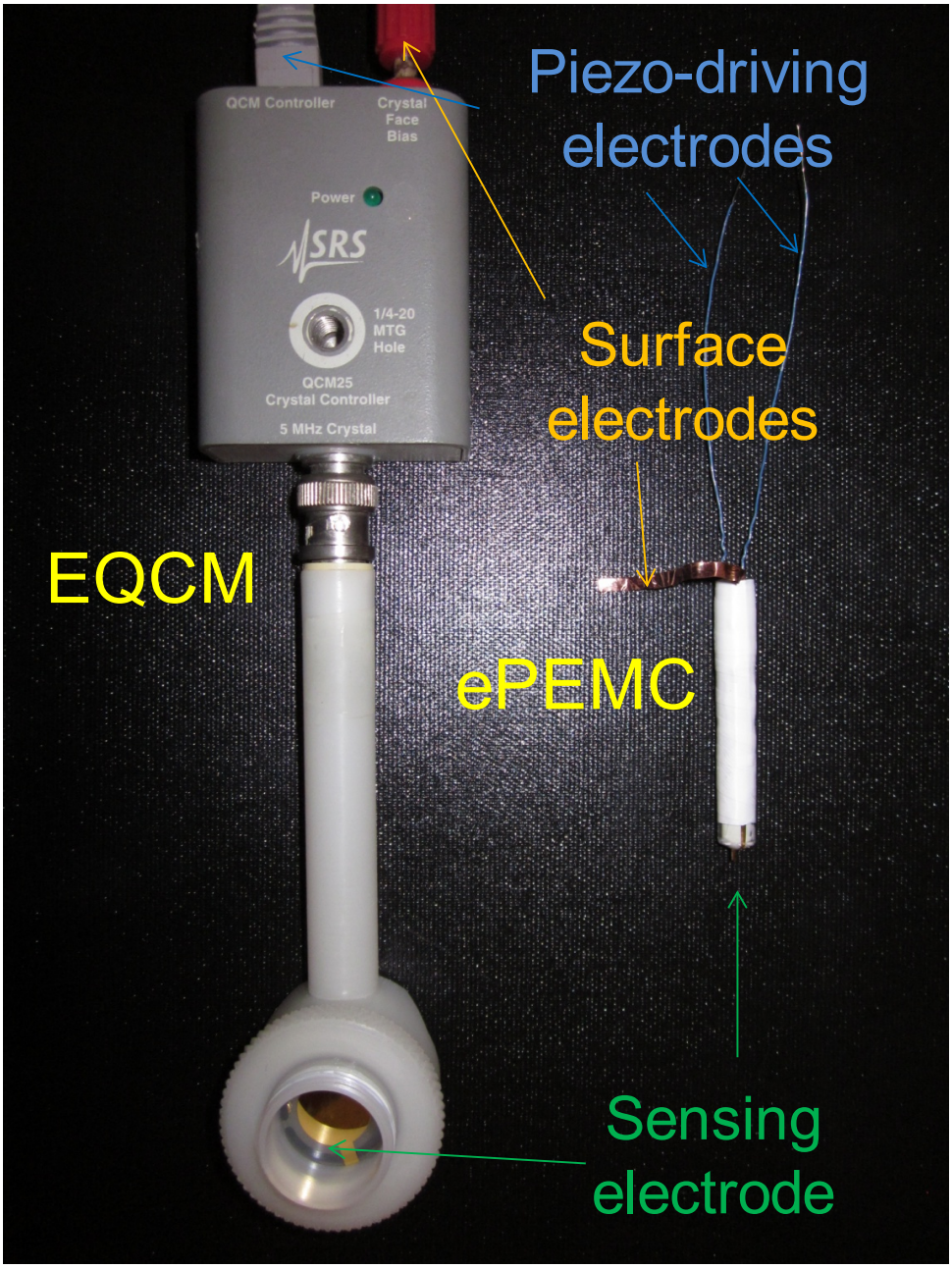

Figure S.1– Comparison of ePEMC with a commercially available electrochemical-quartz crystal microbalance (EQCM) (Stanford Research Systems, SRS, Sunnyvale, CA).

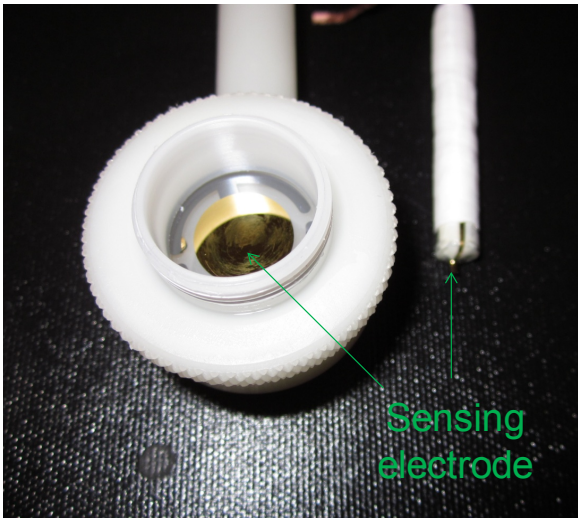

Figure S-2 – Close-up view of sensor working electrodes. EQCM sensor has working electrode area ~ cm^2; ePEMC sensor has working electrode ~ mm^2.

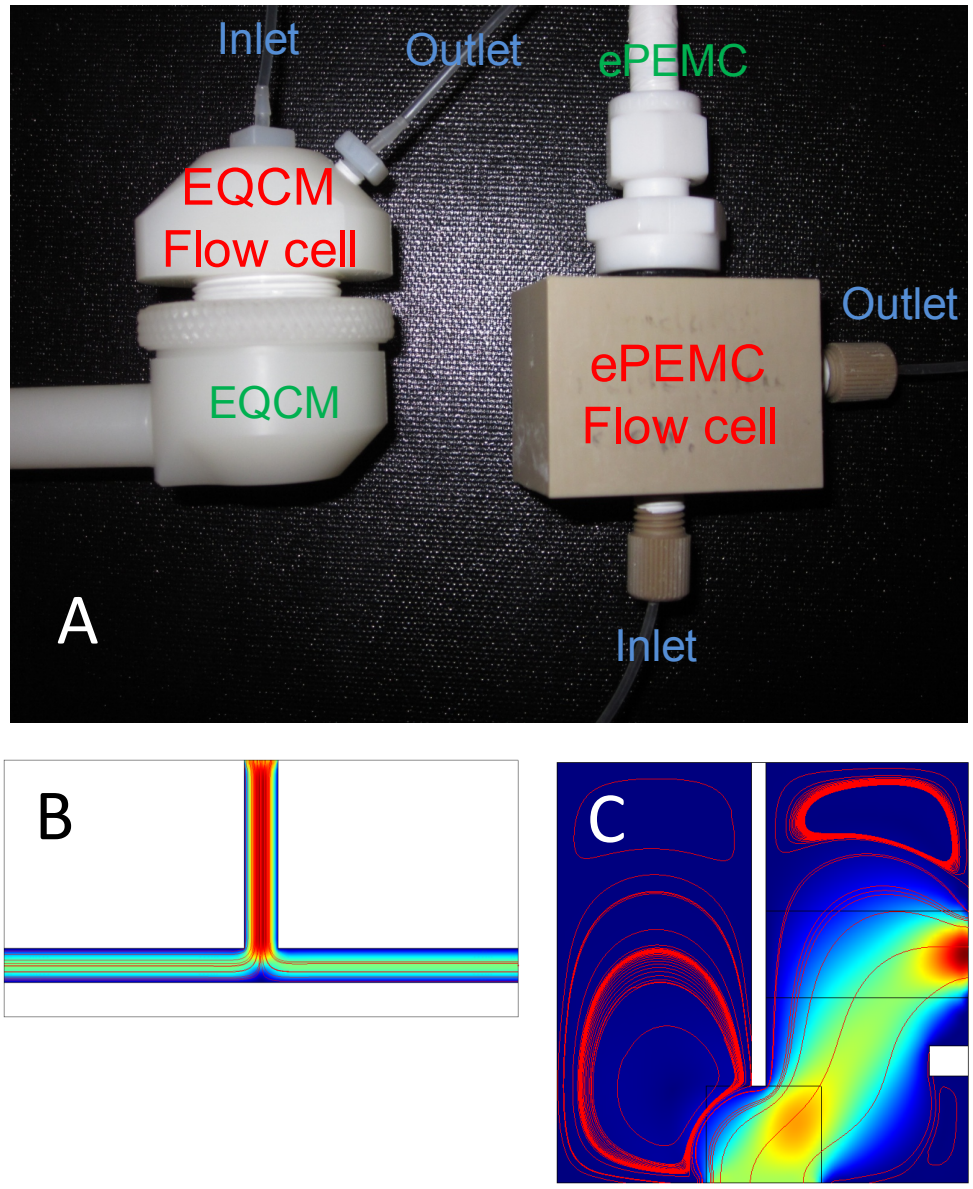

Figure S.3 – (A) Flow cells used for EQCM sensing and ePEMC sensing. Reactor hold-up volumes were 150 µL and ~300 µL, respectively. Finite element modeling software (COMSOL Multiphysics, Vers. 3.5a) was used to calculate flow cell velocity profiles in both the commercially available EQCM (B) and the ePEMC (C) device. Solution was examined in 2-dimensions (2D) using Lagrange-P_2P_1 type elements.

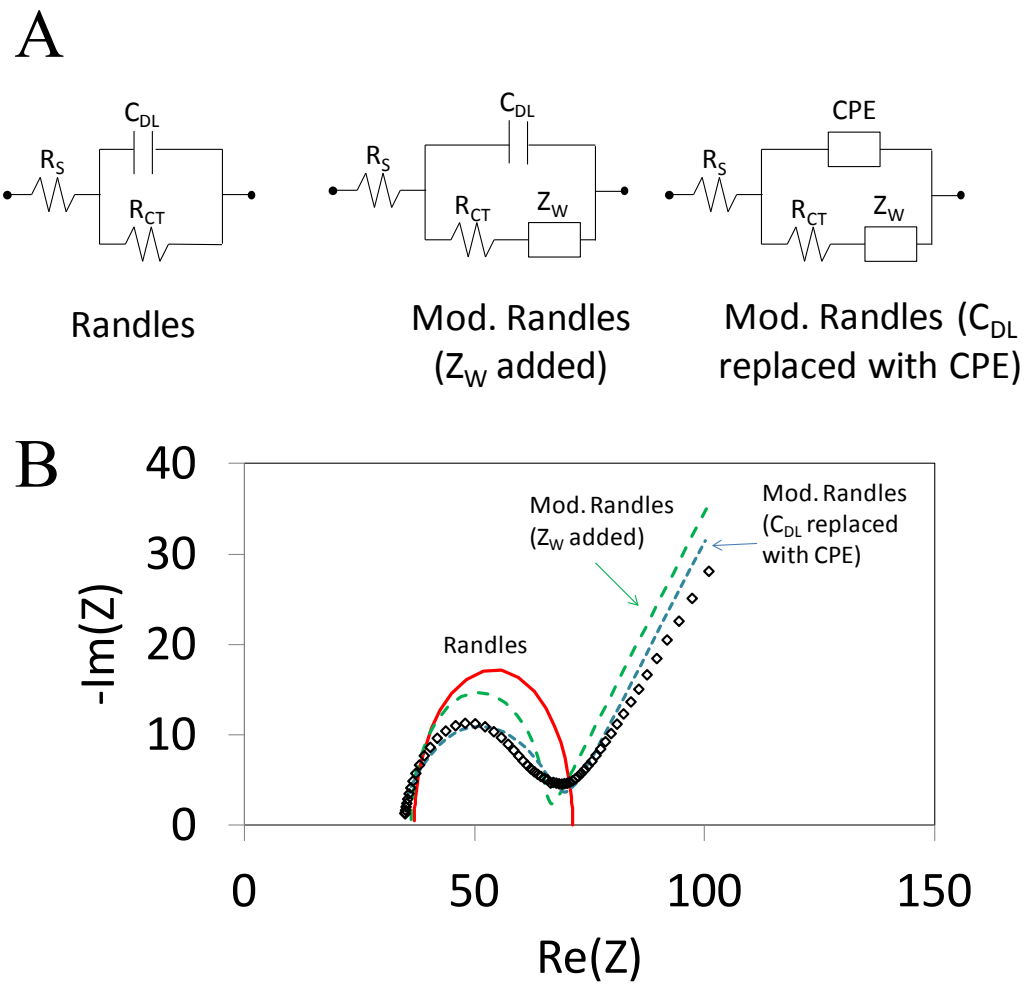

Figure S.4 – (A) Schematics of equivalent circuit models for ePEMC. (B) Fit of above equivalent circuit models via the Simplex Method (Gamry Analyst Software) to ePEMC EIS data. All models accurately capture the biosensing parameter R_{CT} (34, 29, and 35 Ω, respective to the order shown above). These values compared well with the semicircle distance of 34 Ω. Best fit was obtained using the modified Randles circuit (right panel of part (A)) which contains a constant phase element (CPE) in place of the double layer capacitance (C_{DL}). Note both circuits contain an infinite Warburg element (Z_W) in series with the charge transfer resistance (R_{CT}).