

Electronic Supplementary Material

Quantifying and mitigating thermal interference for electrical capacitance tomography measurement of high-temperature fluidized beds

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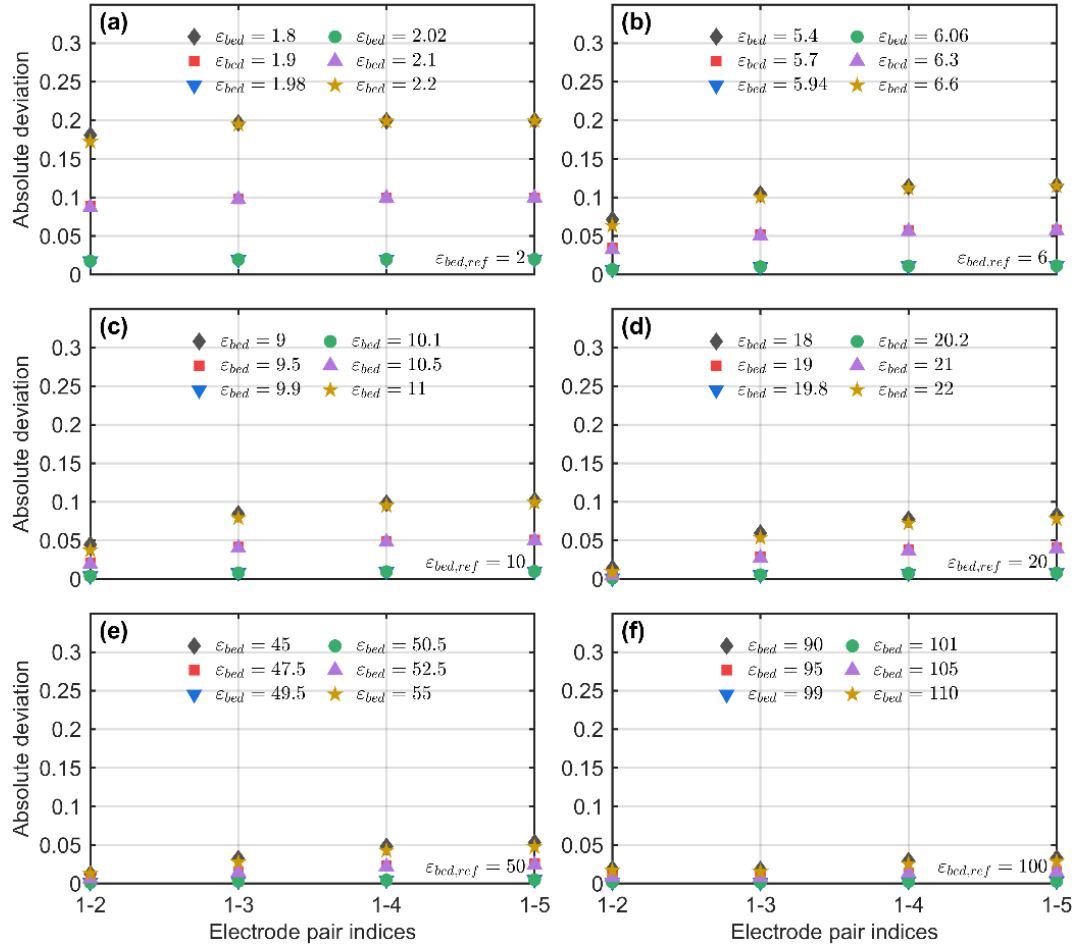


Fig. S1-1: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 1.7 mm, $\epsilon_{wall} = 4$).

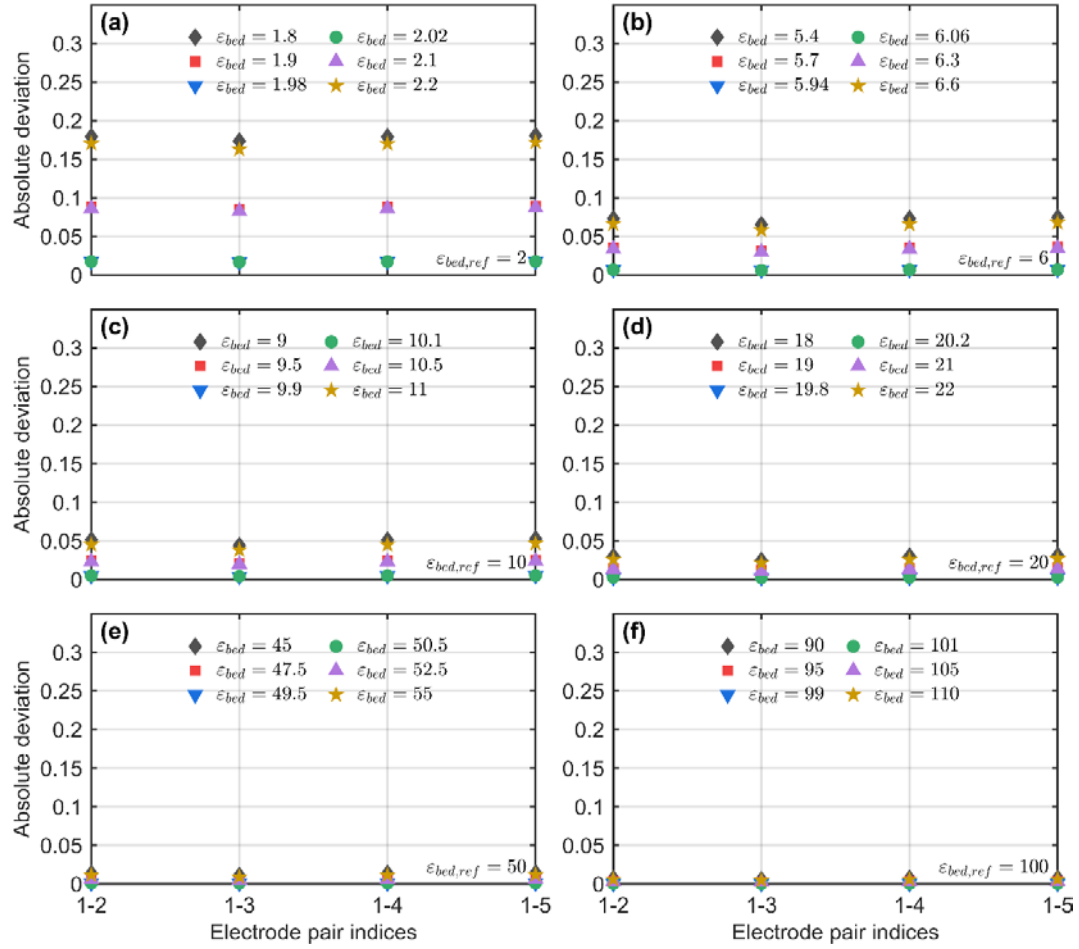


Fig. S1-2: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\varepsilon_{bed} = 2$, (b) $\varepsilon_{bed} = 6$, (c) $\varepsilon_{bed} = 10$, (d) $\varepsilon_{bed} = 20$, (e) $\varepsilon_{bed} = 50$ and (f) $\varepsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 7.8 mm. $\varepsilon_{wall} = 4$).

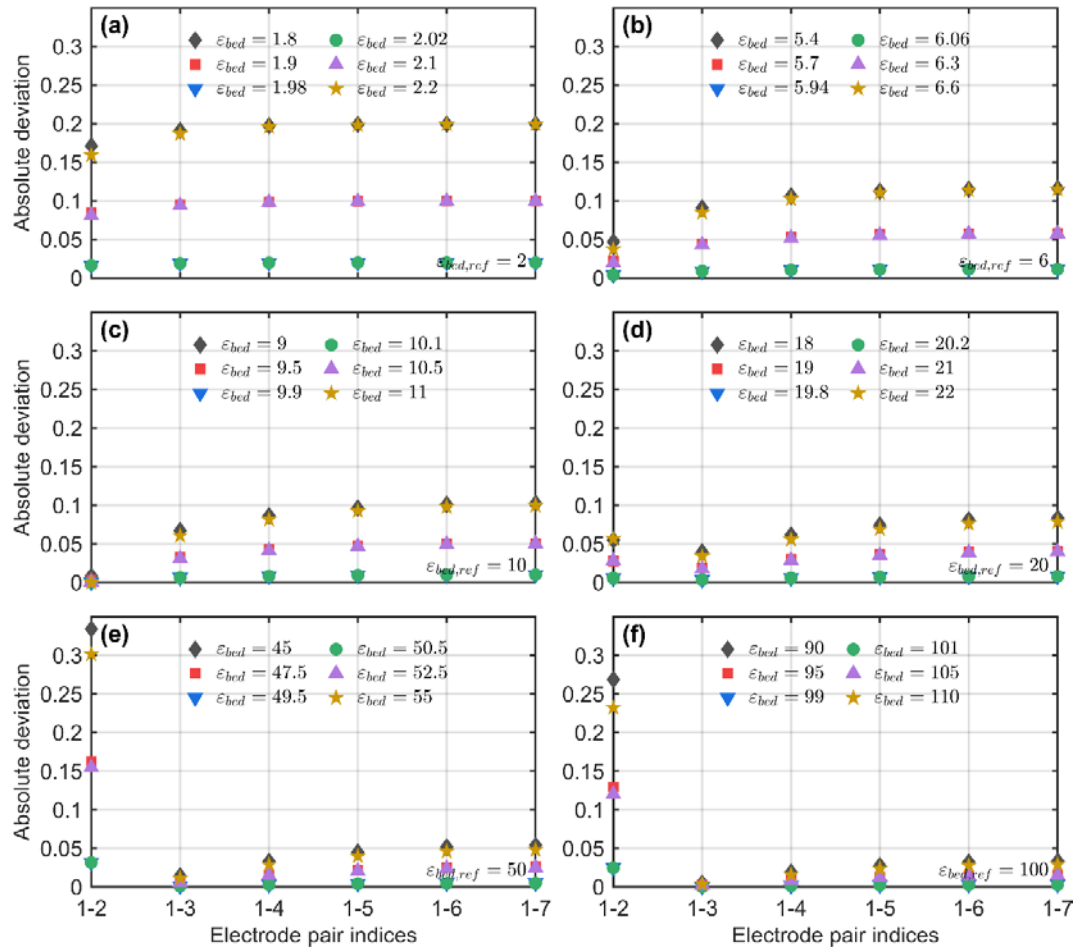


Fig. S1-3: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 1.7 mm, $\epsilon_{wall} = 4$).

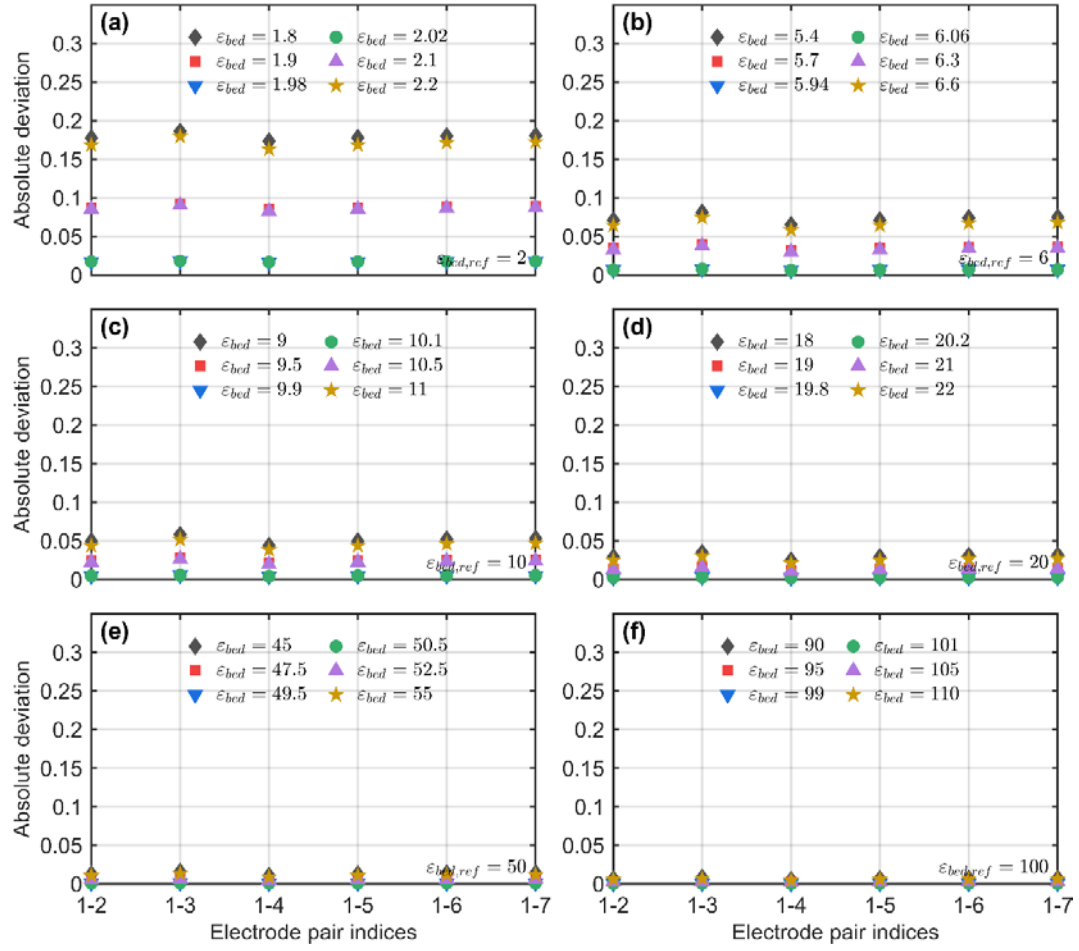


Fig. S1-4: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 7.8 mm, $\epsilon_{wall} = 4$).

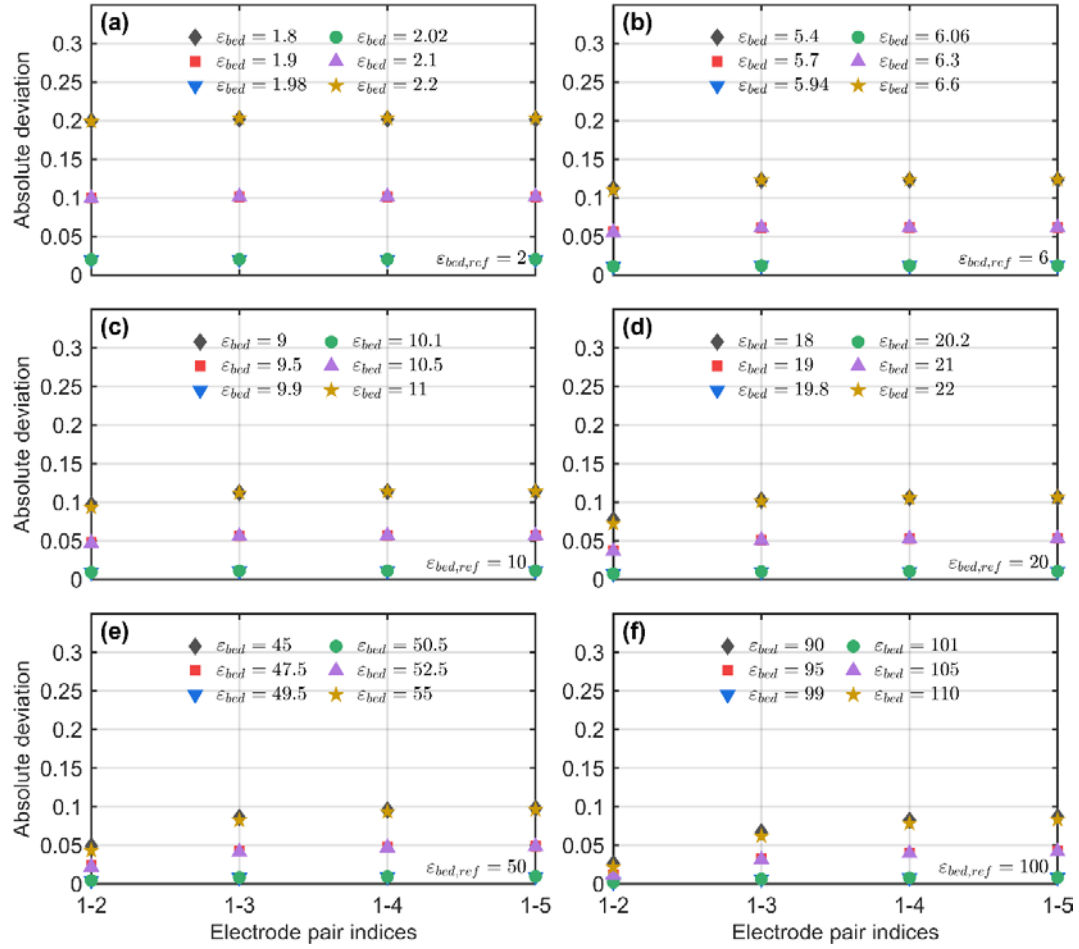


Fig. S2-1: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 9.5 mm. $\epsilon_{wall} = 4$).

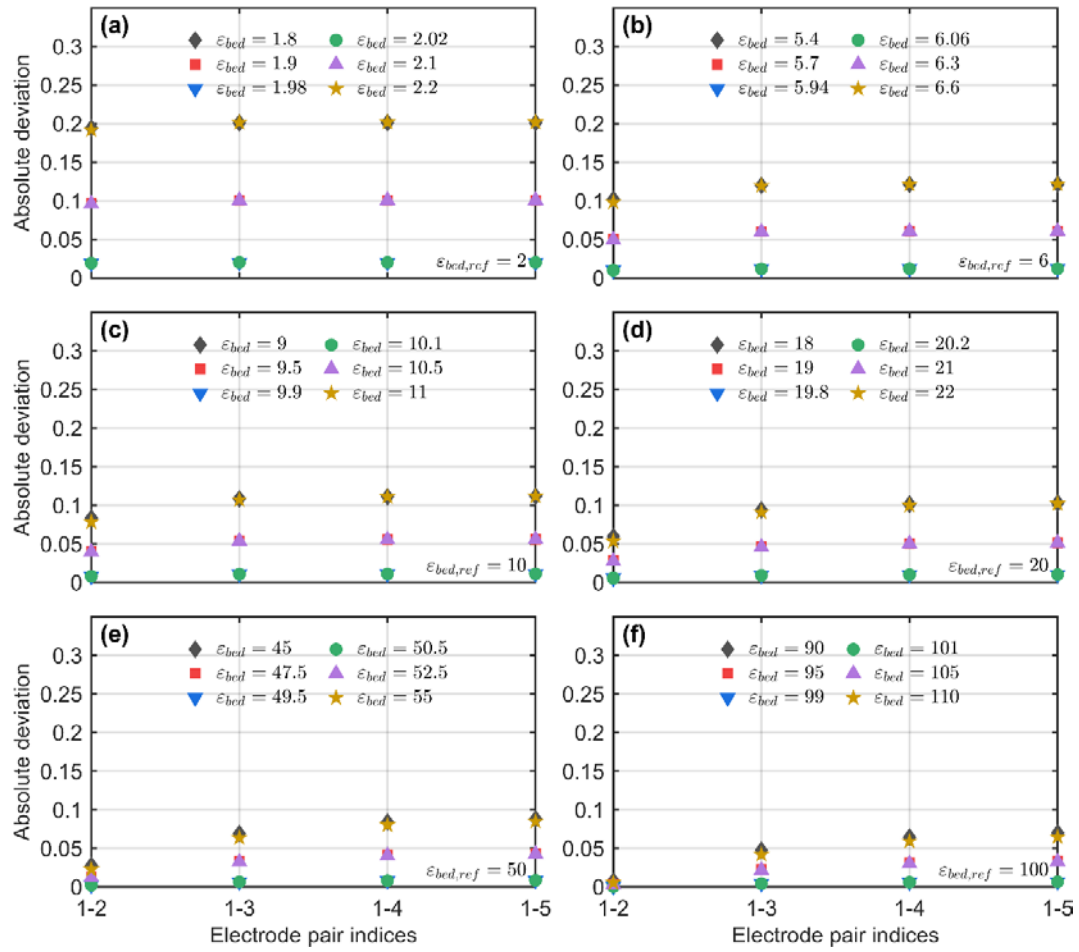


Fig. S2-2: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\varepsilon_{bed} = 2$, (b) $\varepsilon_{bed} = 6$, (c) $\varepsilon_{bed} = 10$, (d) $\varepsilon_{bed} = 20$, (e) $\varepsilon_{bed} = 50$ and (f) $\varepsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 19 mm. $\varepsilon_{wall} = 4$).

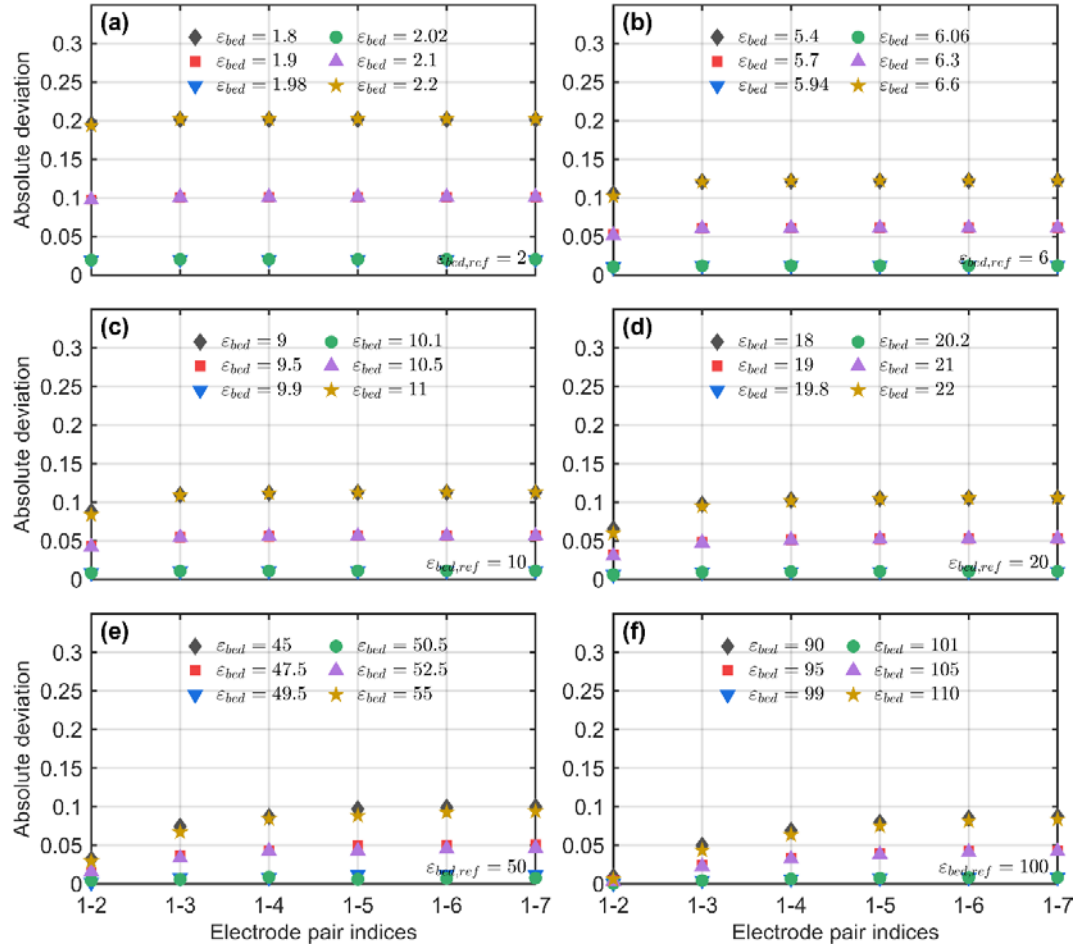


Fig. S2-3: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 9.5 mm. $\epsilon_{wall} = 4$).

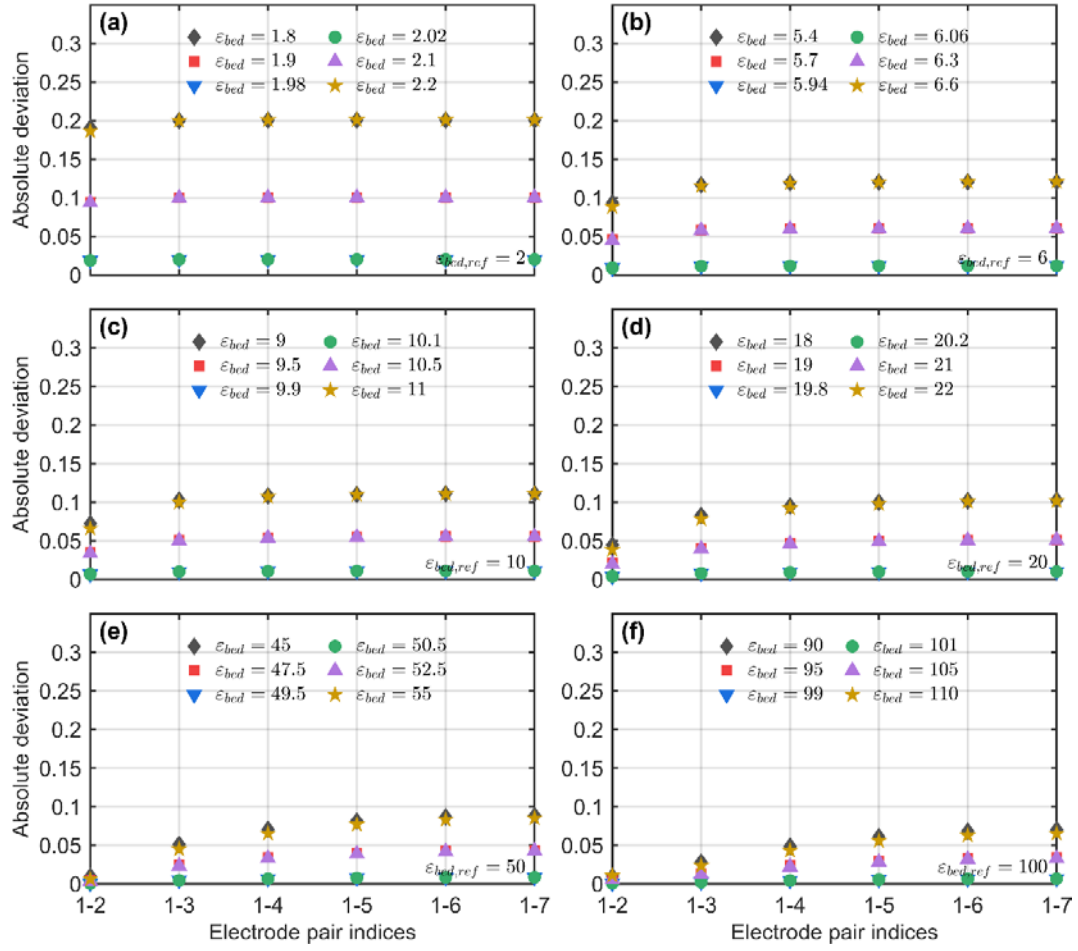


Fig. S2-4: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 19 mm. $\epsilon_{wall} = 4$).

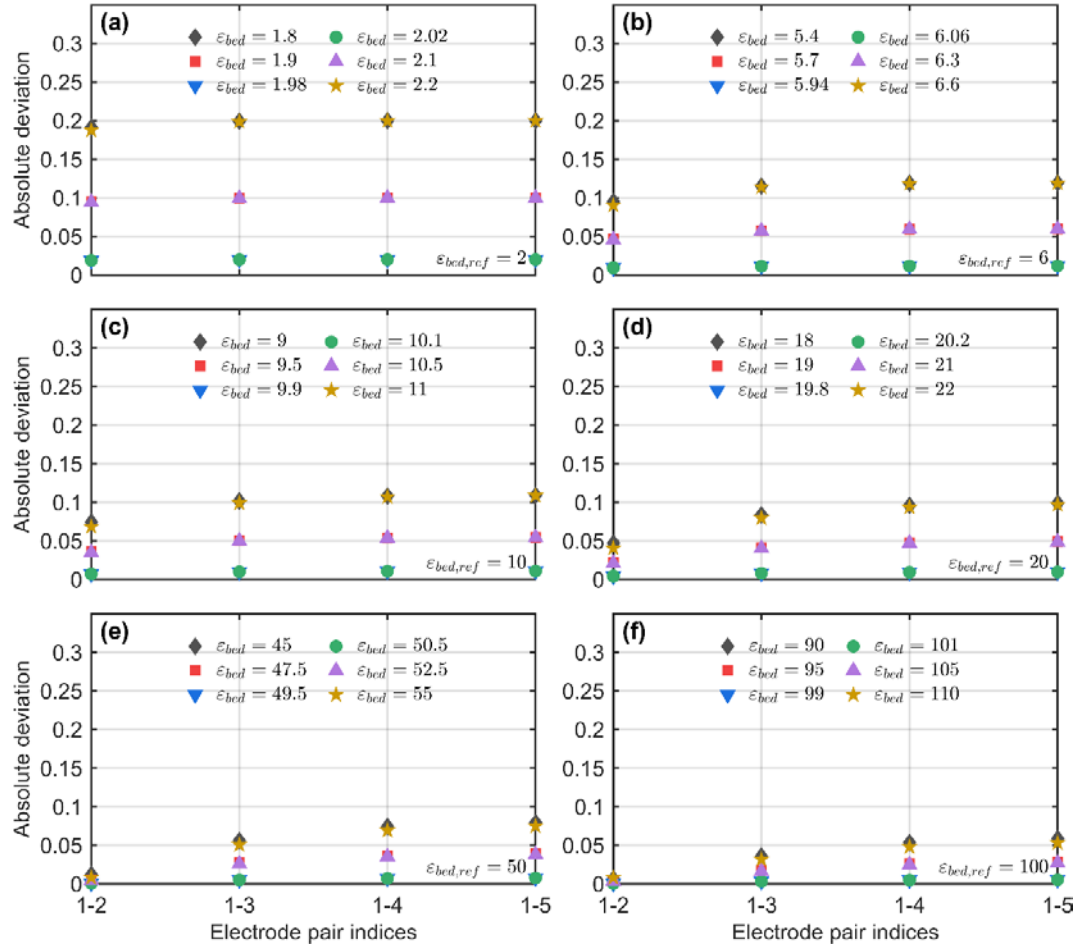


Fig. S3-1: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 1.7 mm, $\epsilon_{wall} = 10$).

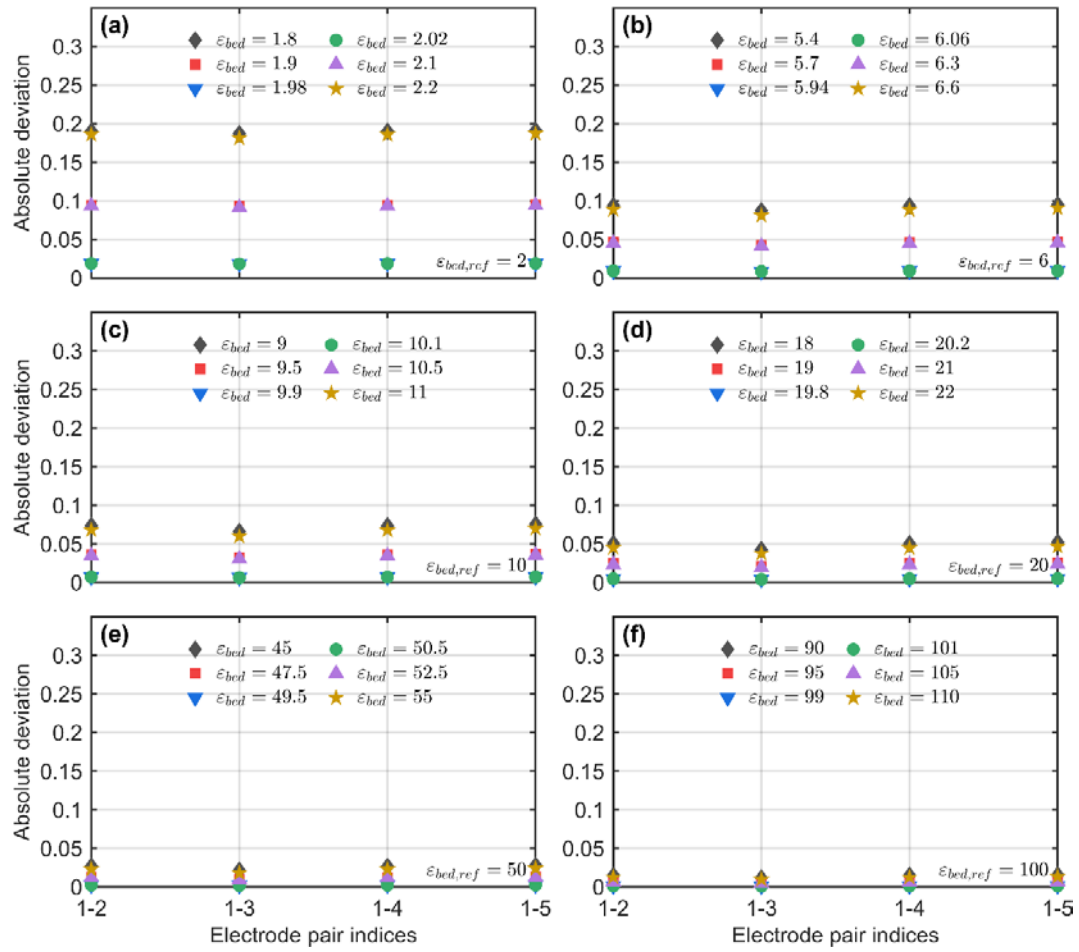


Fig. S3-2: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 7.8 mm. $\epsilon_{wall} = 10$).

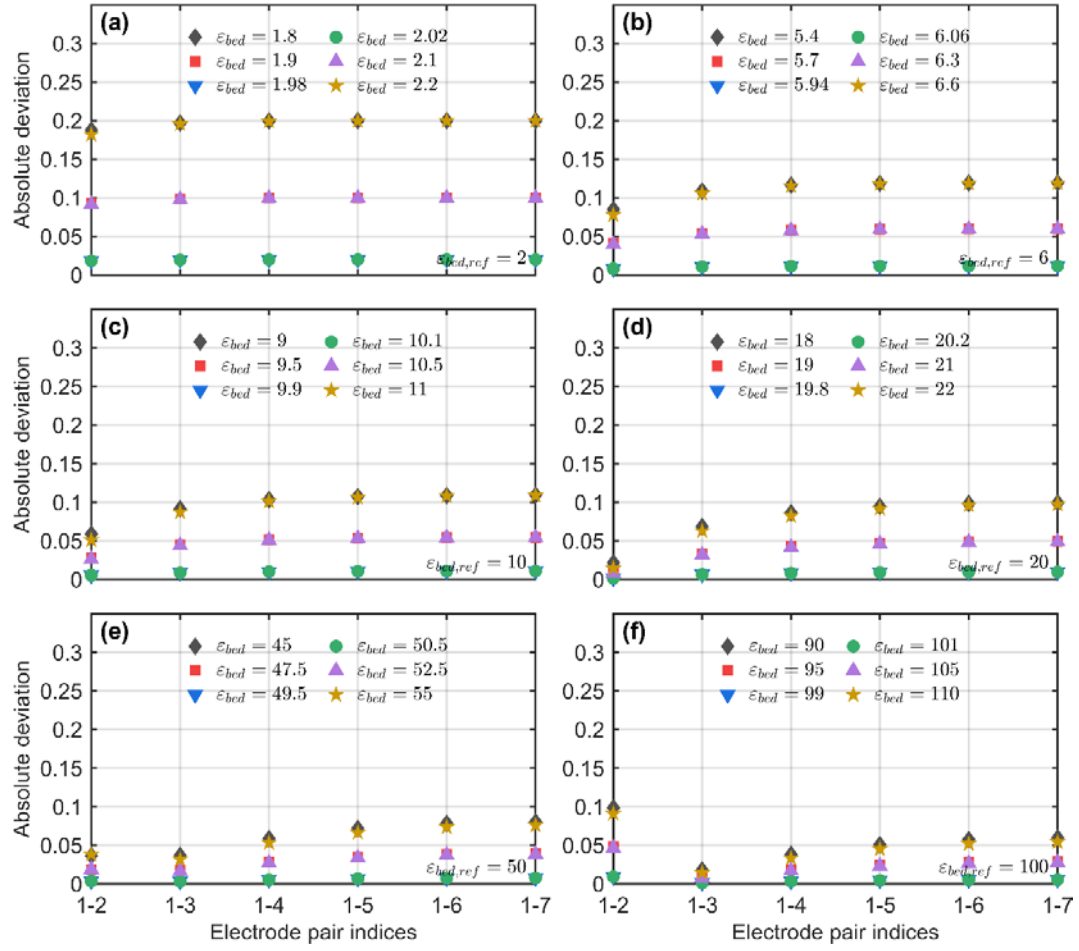


Fig. S3-3: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 1.7 mm. $\epsilon_{wall} = 10$).

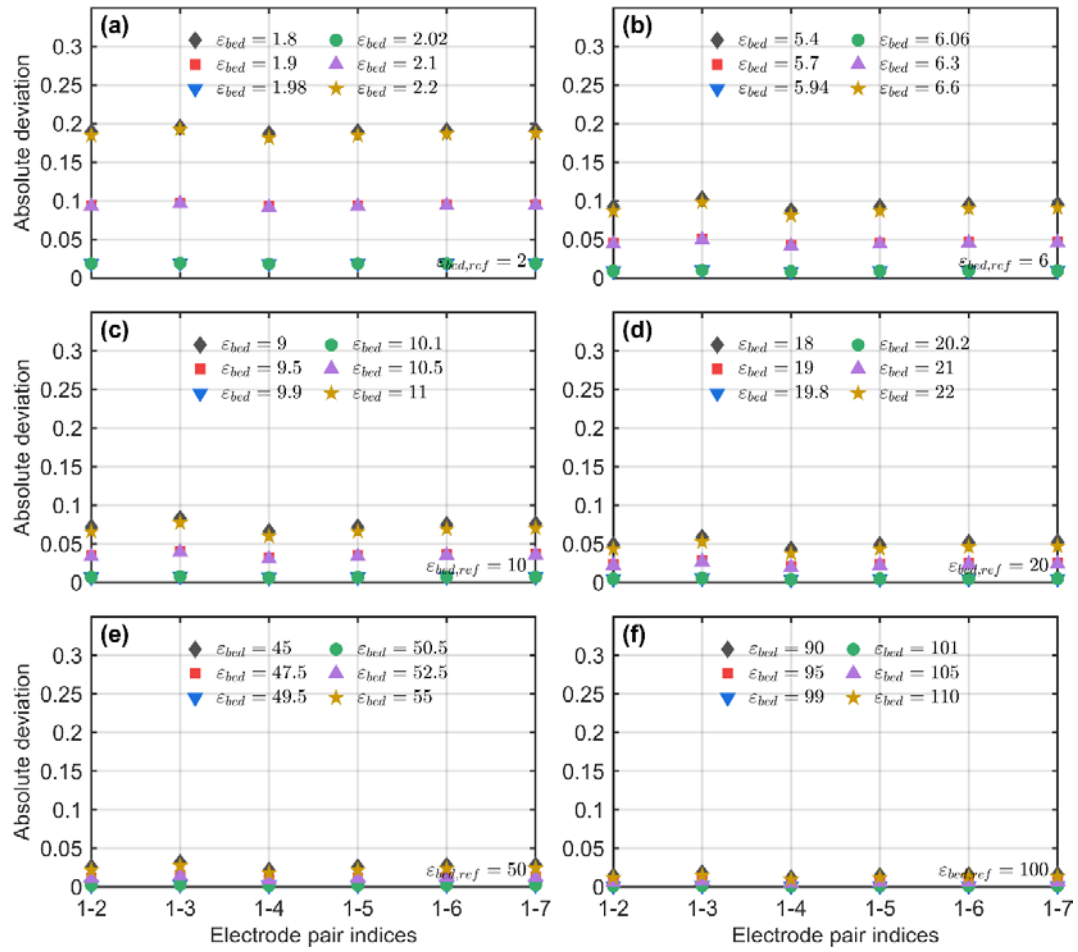


Fig. S3-4: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 27 mm, thickness: 7.8 mm. $\epsilon_{wall} = 10$).

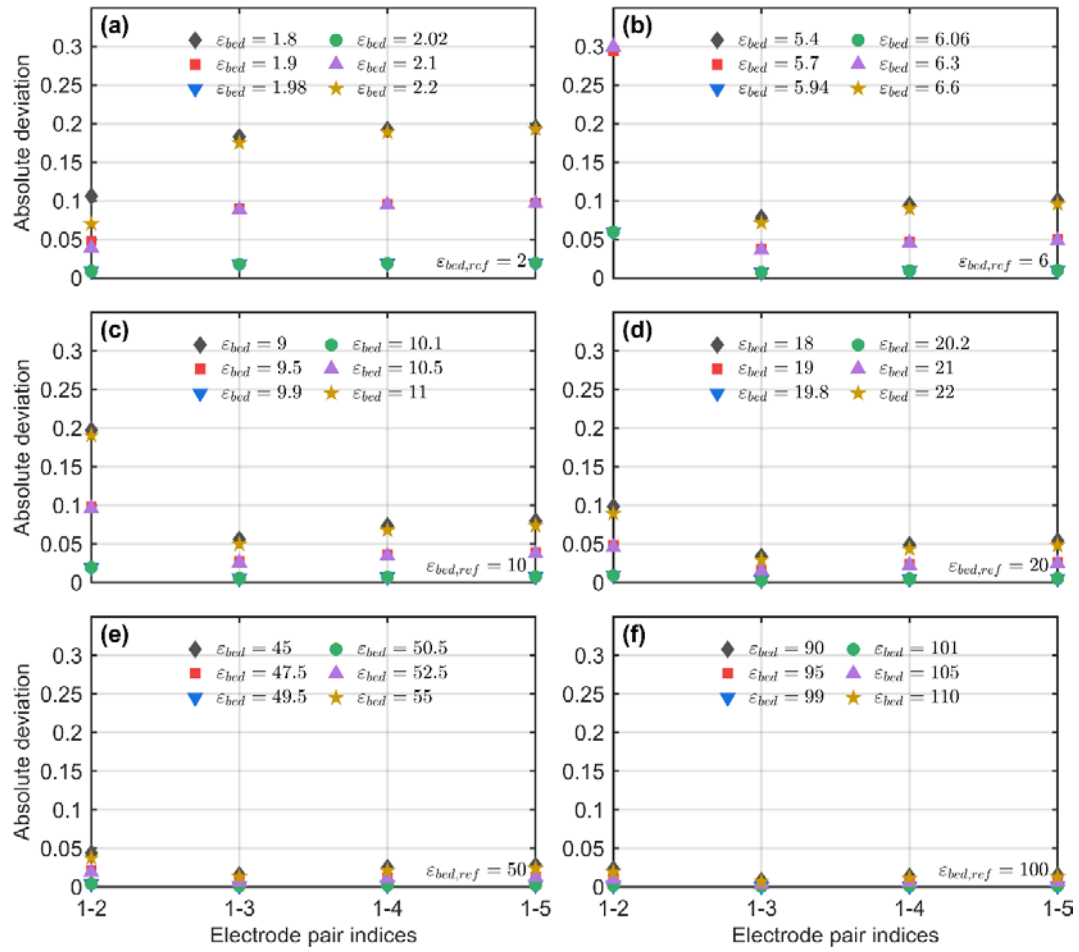


Fig. S4-1: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 114 mm, thickness: 17.1 mm. $\epsilon_{wall} = 4$).

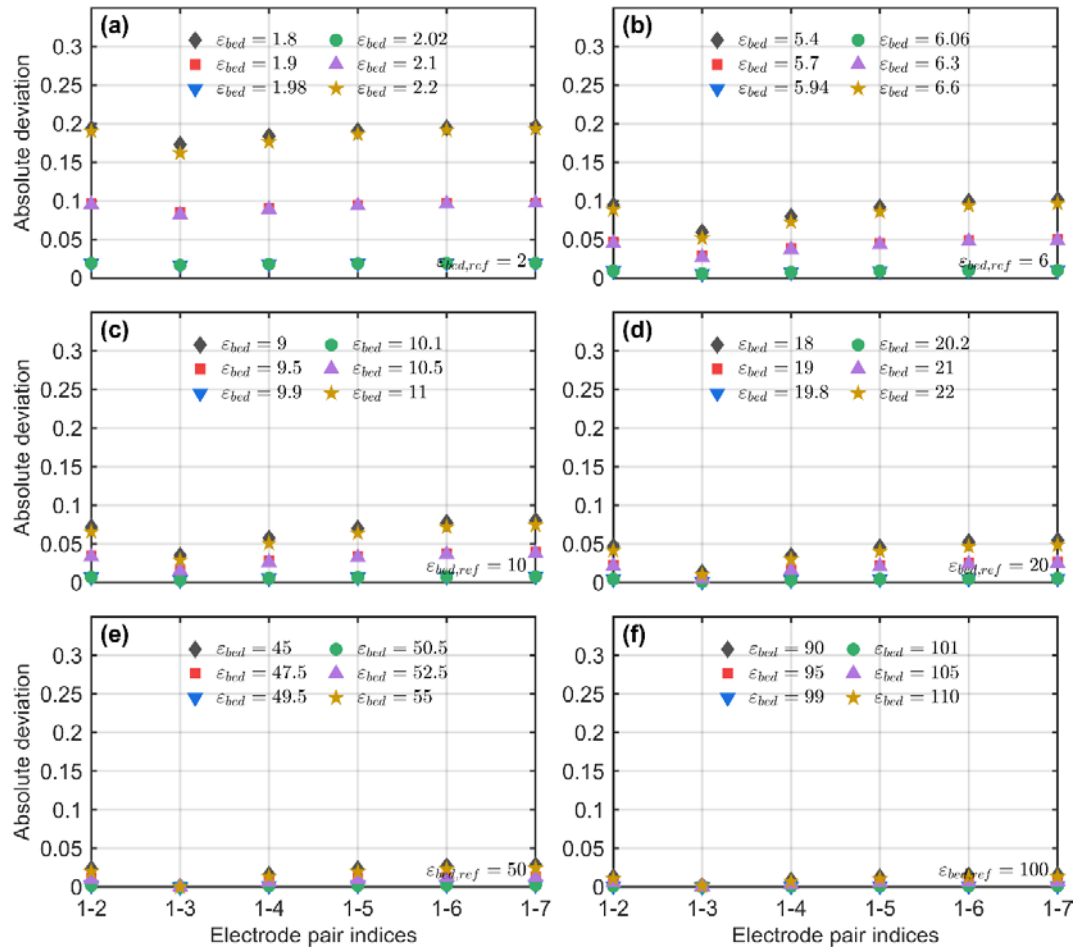


Fig. S4-2: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 114 mm, thickness: 17.1 mm. $\epsilon_{wall} = 4$).

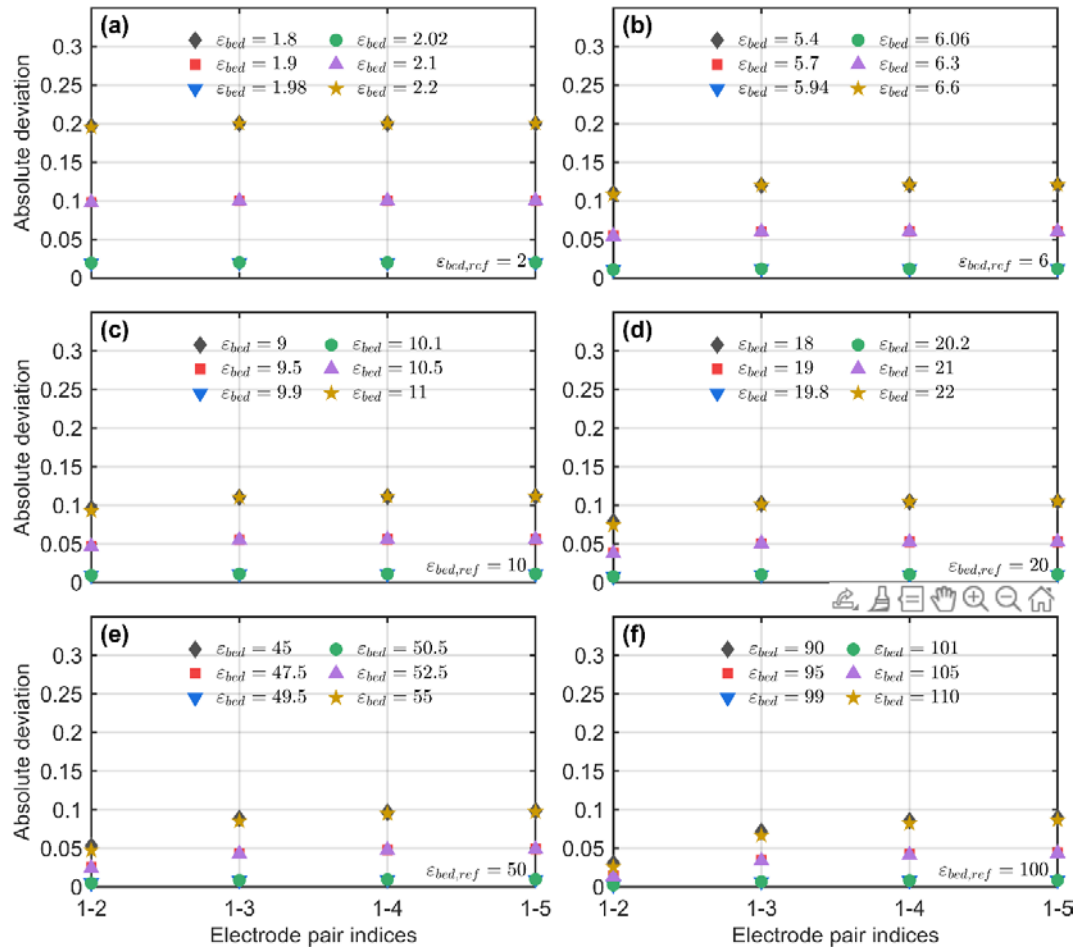


Fig. S5-1: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 114 mm, thickness: 2.1 mm. $\epsilon_{wall} = 10$).

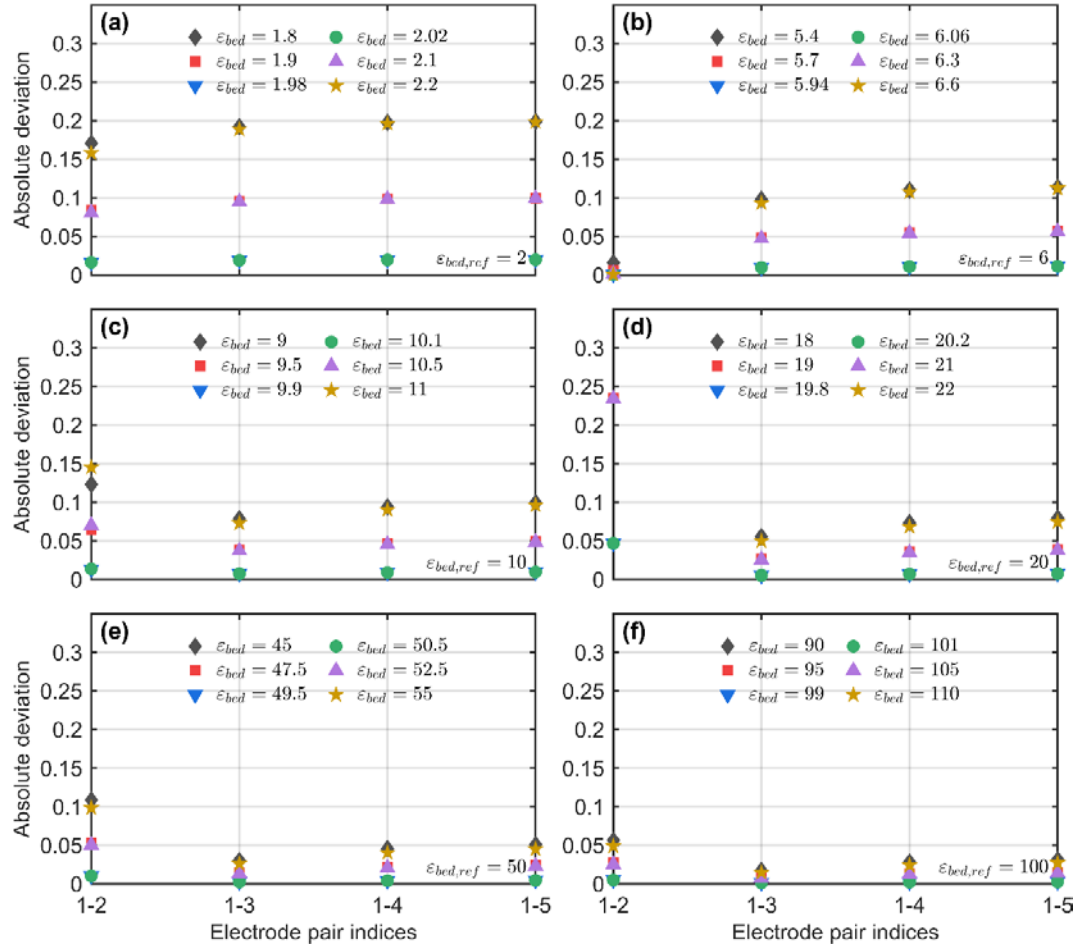


Fig. S5-2: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 114 mm, thickness: 17.1 mm. $\epsilon_{wall} = 10$).

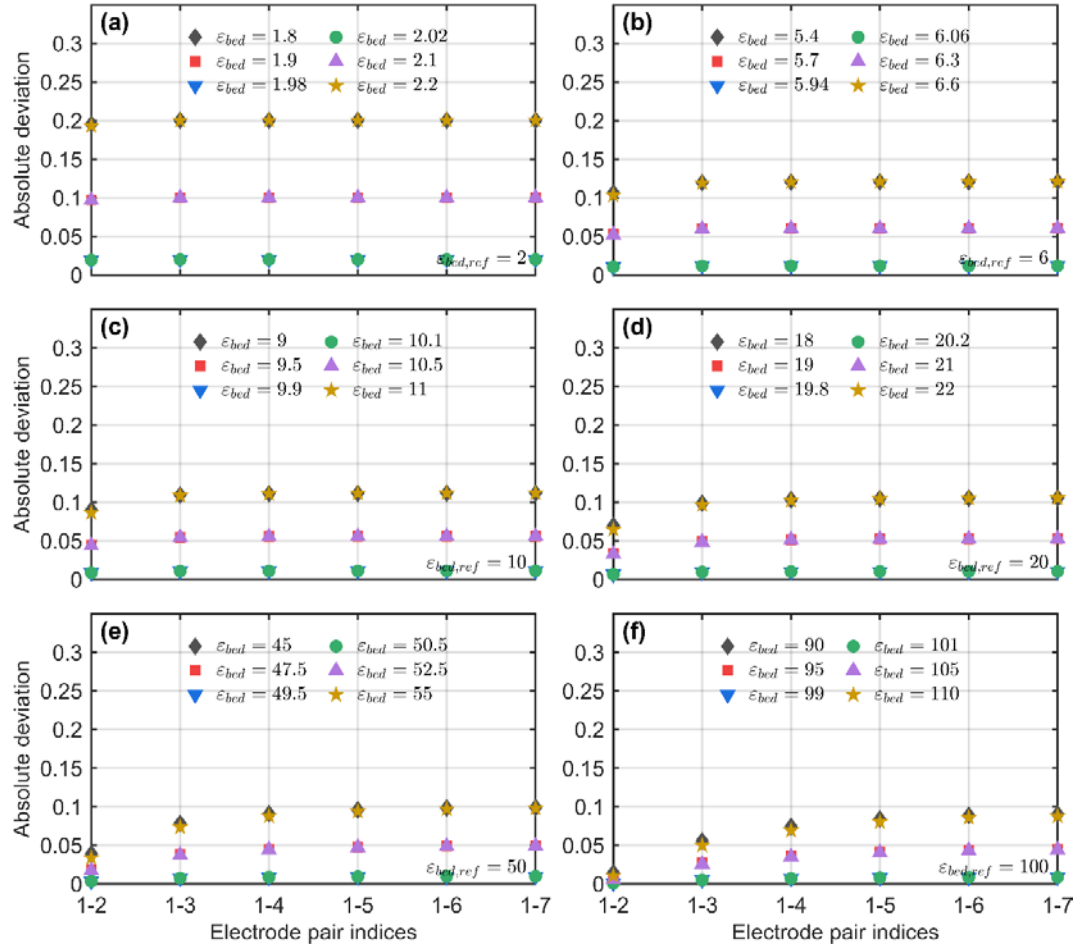


Fig. S5-3: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 114 mm, thickness: 2.1 mm. $\epsilon_{wall} = 10$).

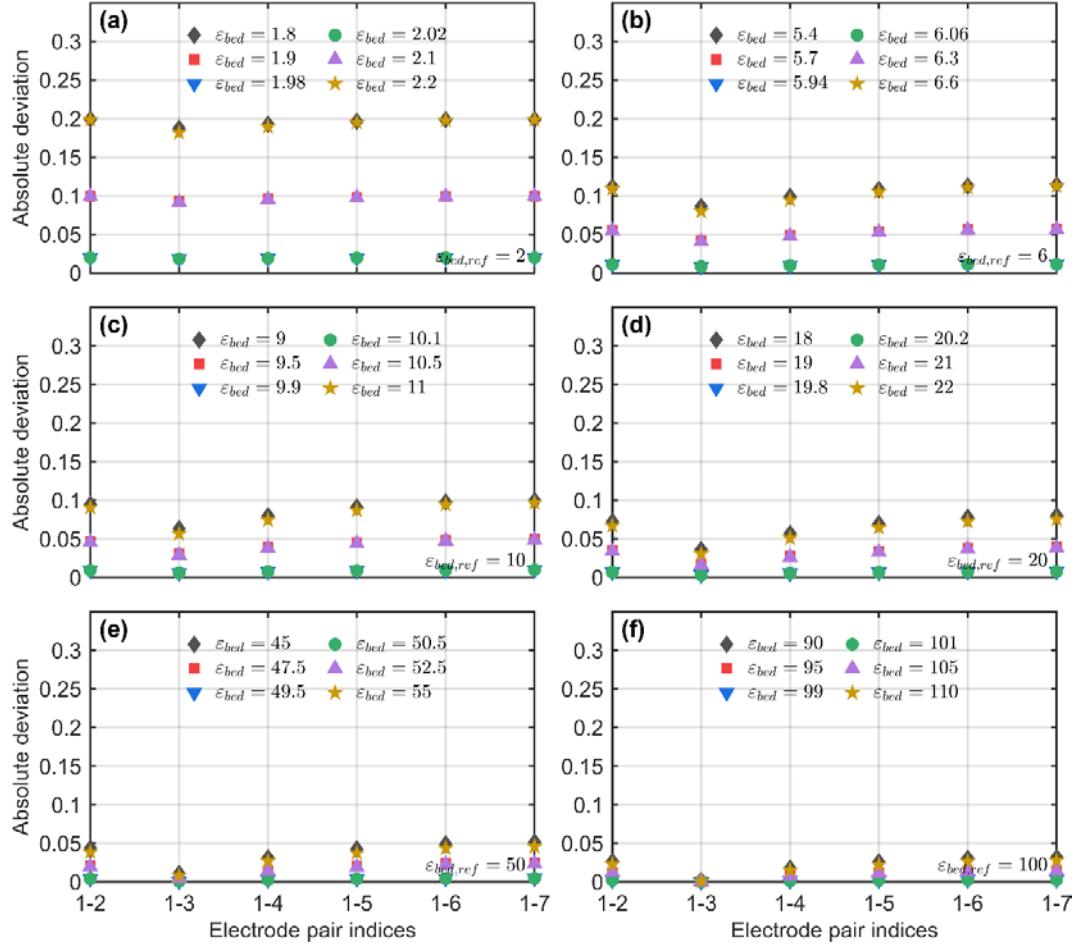


Fig. S5-4: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 114 mm, thickness: 17.1 mm. $\epsilon_{wall} = 10$).

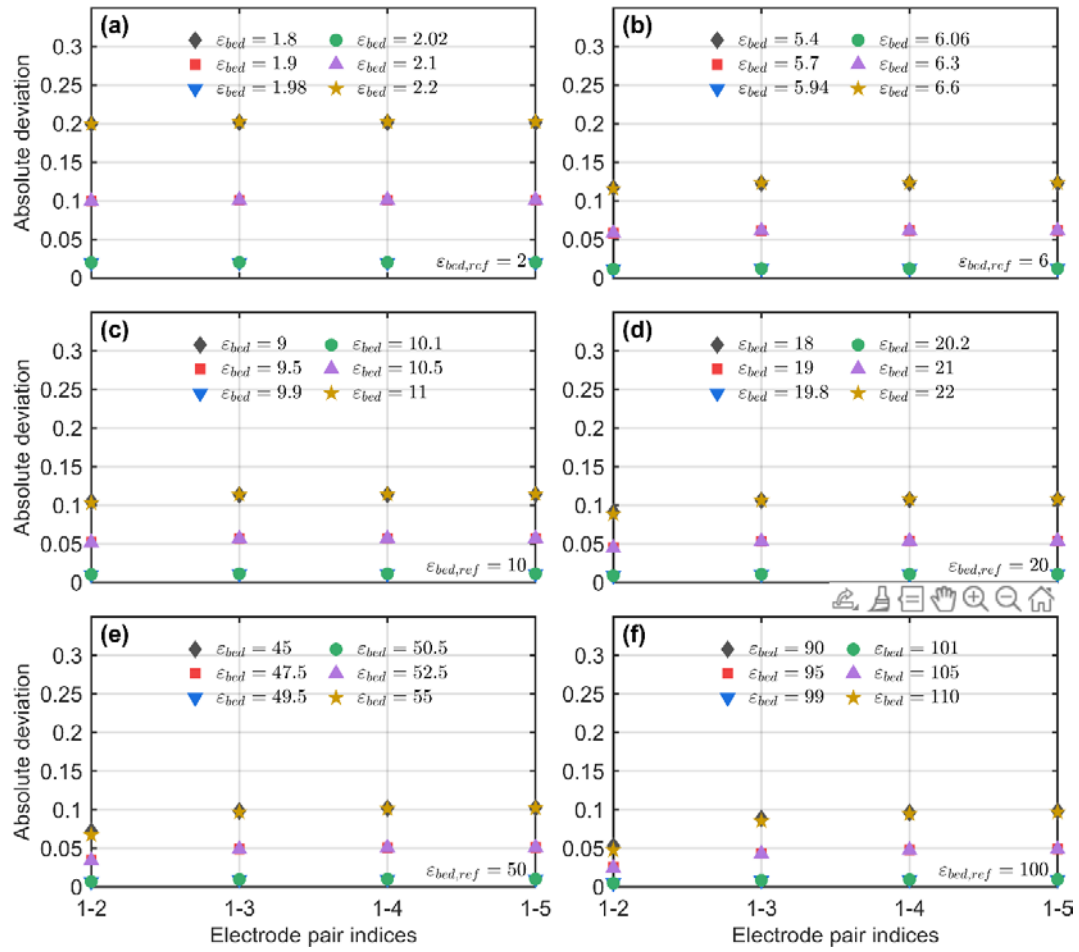


Fig. S6-1: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 9.5 mm. $\epsilon_{wall} = 10$).

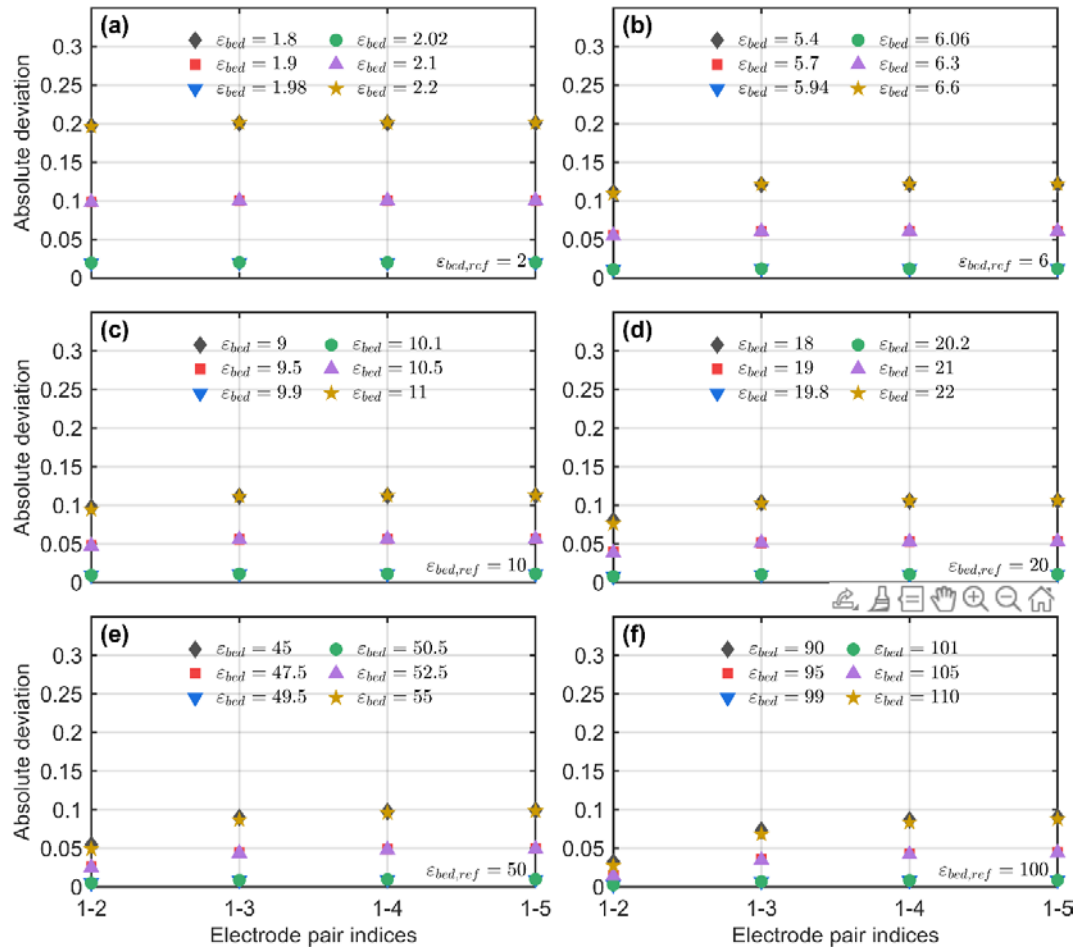


Fig. S6-2: Absolute deviations of normalized capacitance induced by varying thermal perturbations for an 8-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 19 mm. $\epsilon_{wall} = 10$).

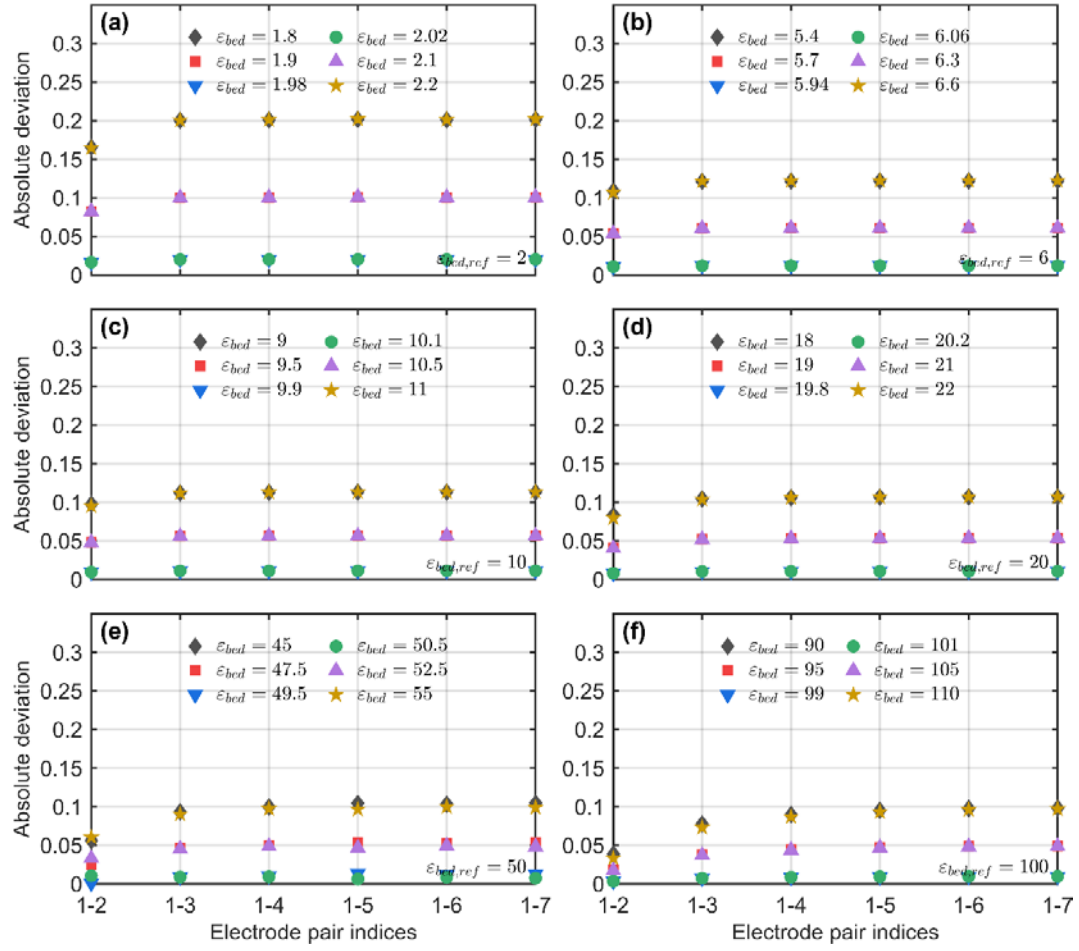


Fig. S6-3: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 9.5 mm. $\epsilon_{wall} = 10$).

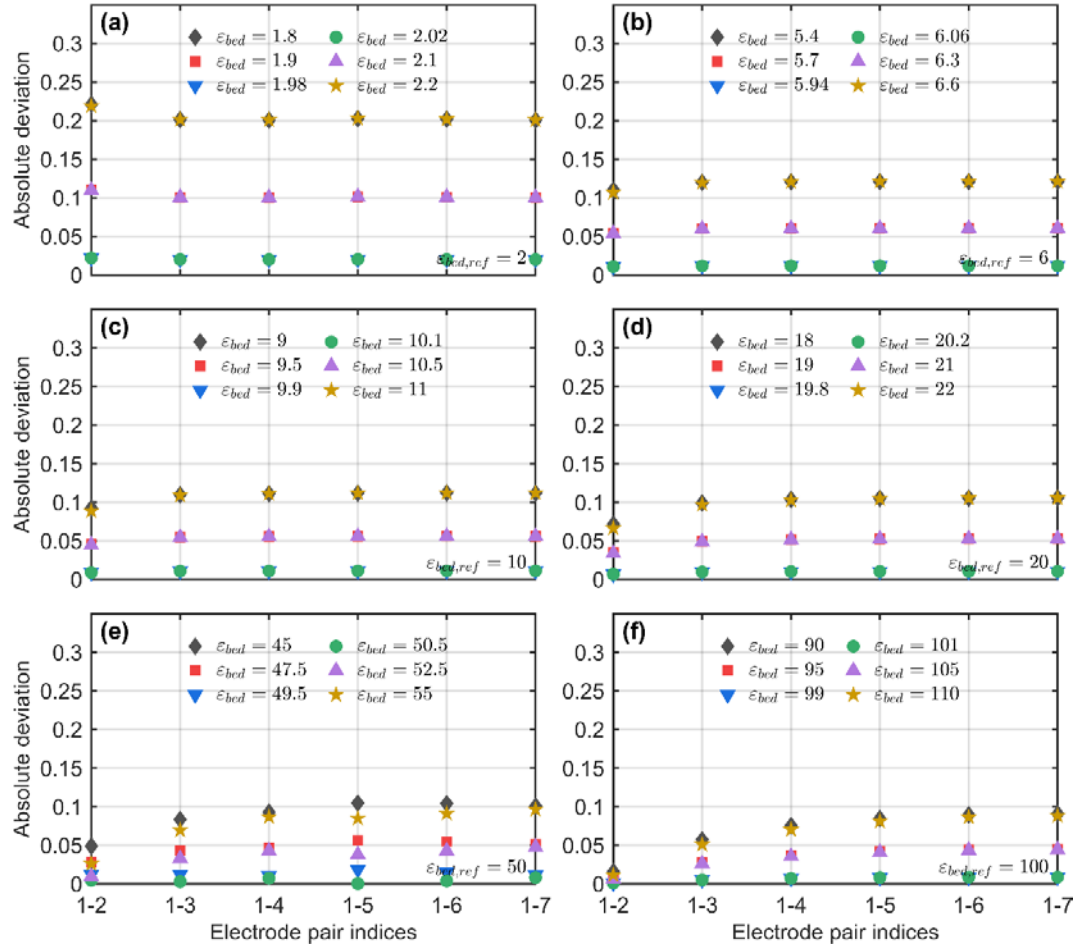


Fig. S6-4: Absolute deviations of normalized capacitance induced by varying thermal perturbations for a 12-electrode ECT sensor. The evaluations correspond to six distinct baseline packed-bed permittivity: (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$ and (f) $\epsilon_{bed} = 100$. (Outer diameter: 1067 mm, thickness: 19 mm. $\epsilon_{wall} = 10$).

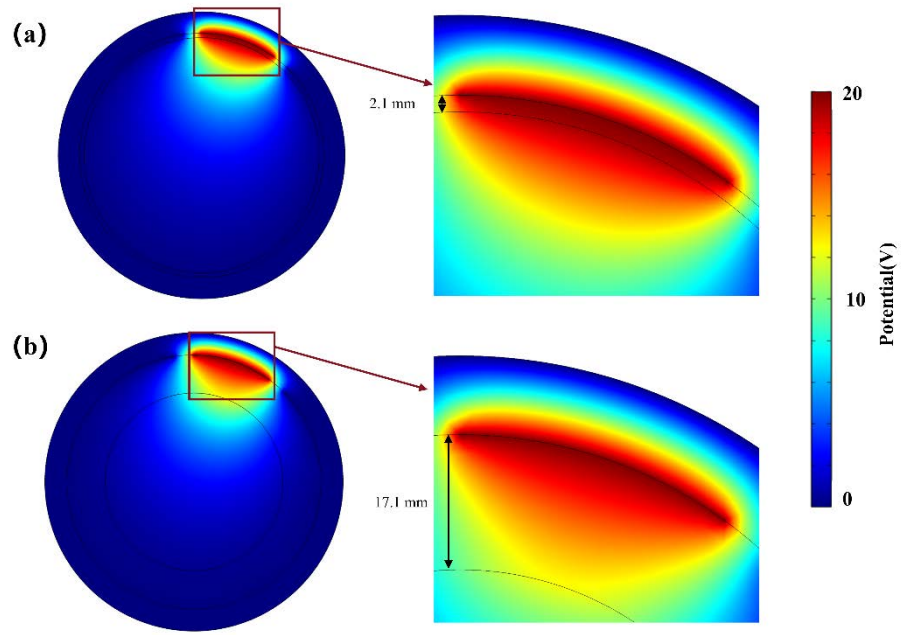


Figure S7. Electrical potential distributions under single-electrode excitation in a 114 mm column with wall thicknesses of (a) 2.1 mm and (b) 17.1 mm, with local magnifications highlighting the regions near the excited electrode.

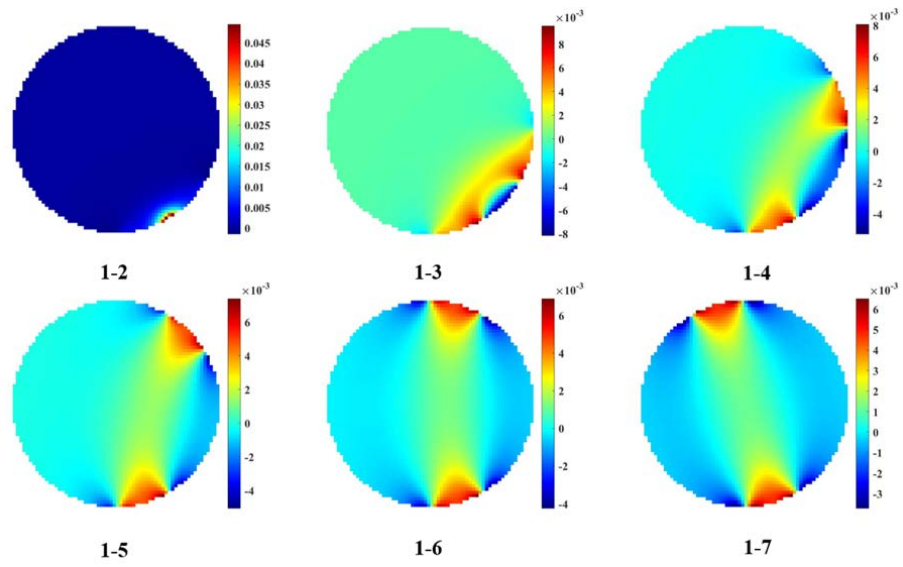


Fig. S8: Sensitivity intensity distribution of different electrode pairs of 12-electrode ECT sensor.

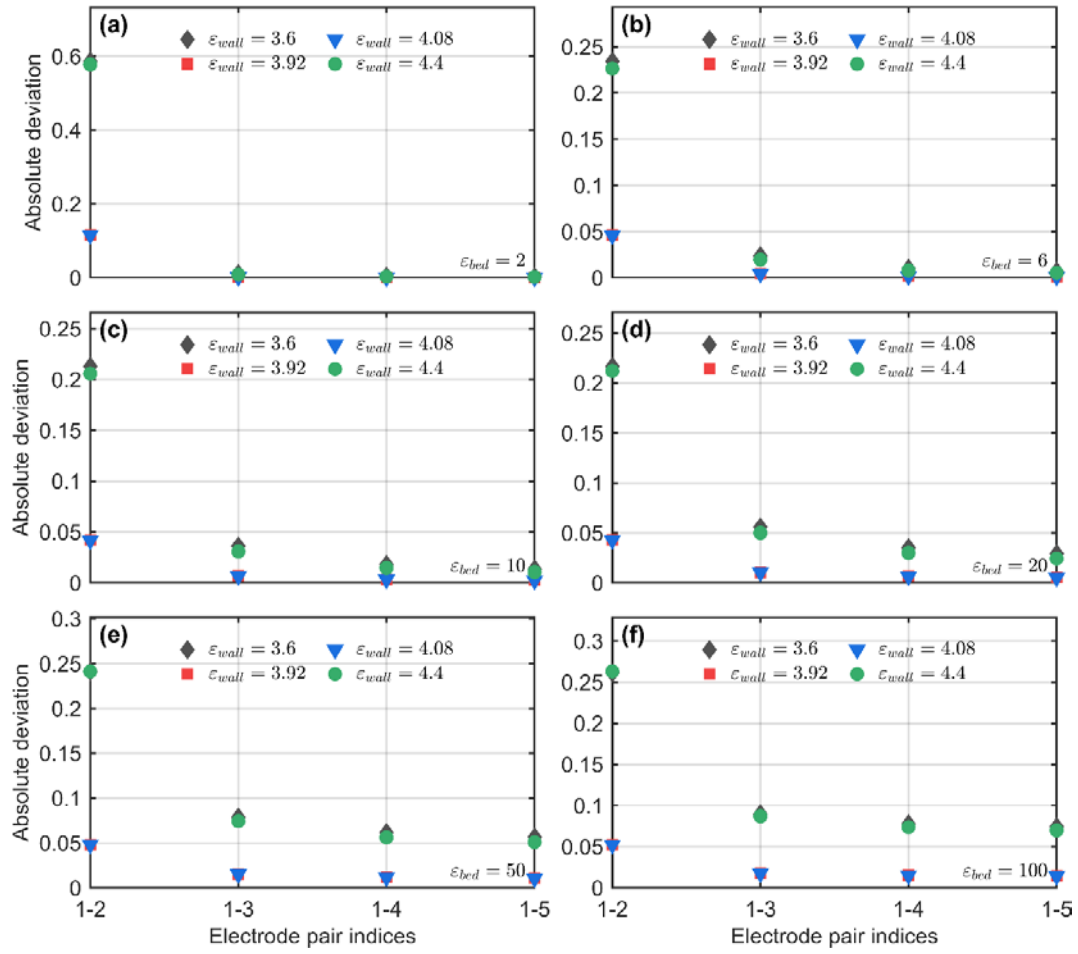


Fig. S9-1: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 27 mm outer diameter column with a 1.7 mm thickness.

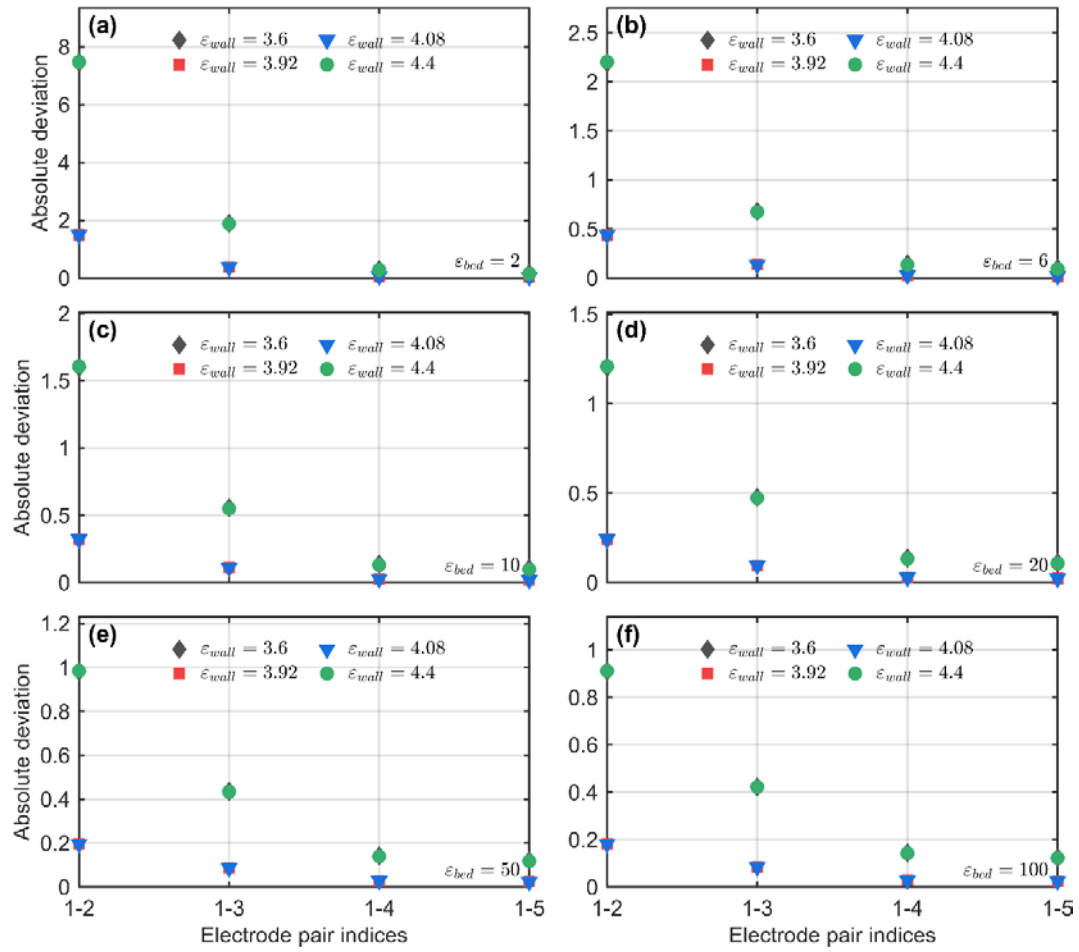


Fig. S9-2: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 27 mm outer diameter column with a 7.8 mm thickness.

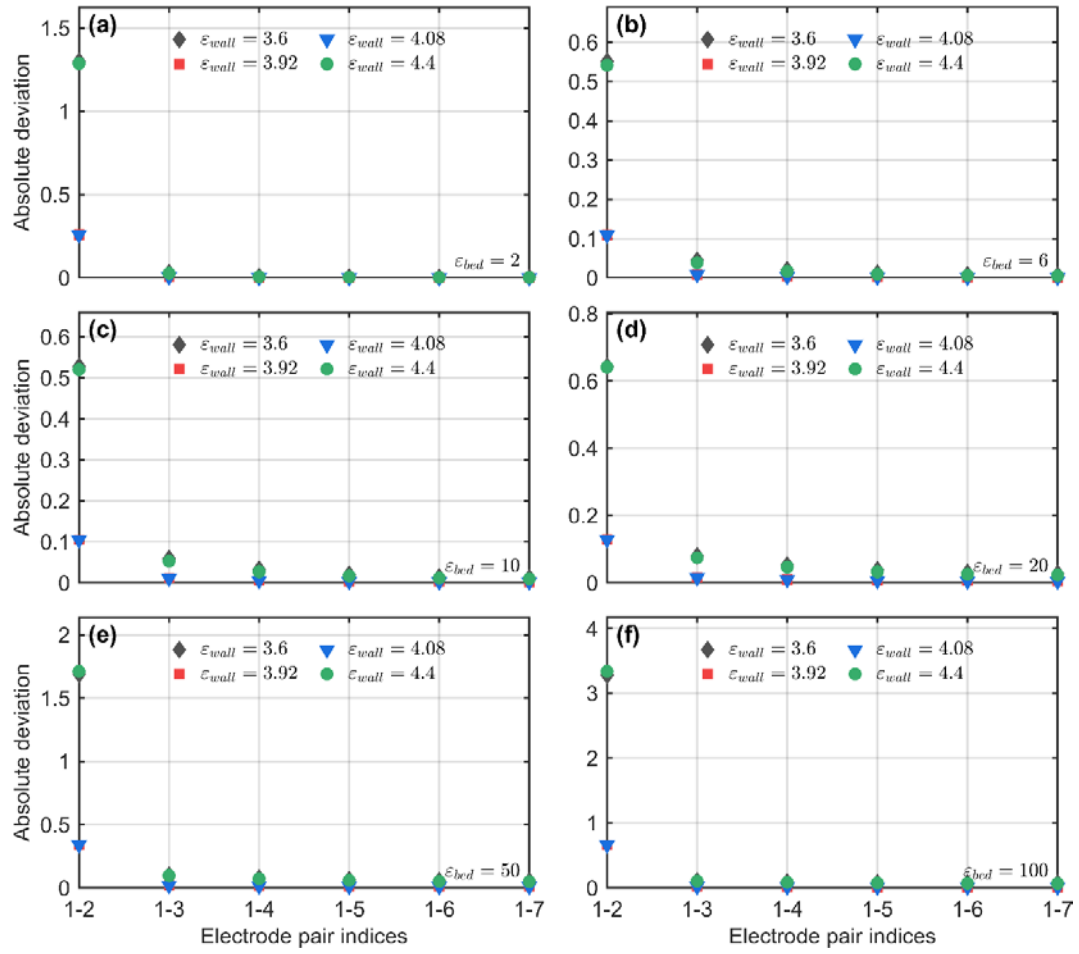


Fig. S9-3: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed}=2$, (b) $\epsilon_{bed}=6$, (c) $\epsilon_{bed}=10$, (d) $\epsilon_{bed}=20$, (e) $\epsilon_{bed}=50$, and (f) $\epsilon_{bed}=100$. 12-electrode ECT sensor mounted on a 27 mm outer diameter column with a 1.7 mm thickness.

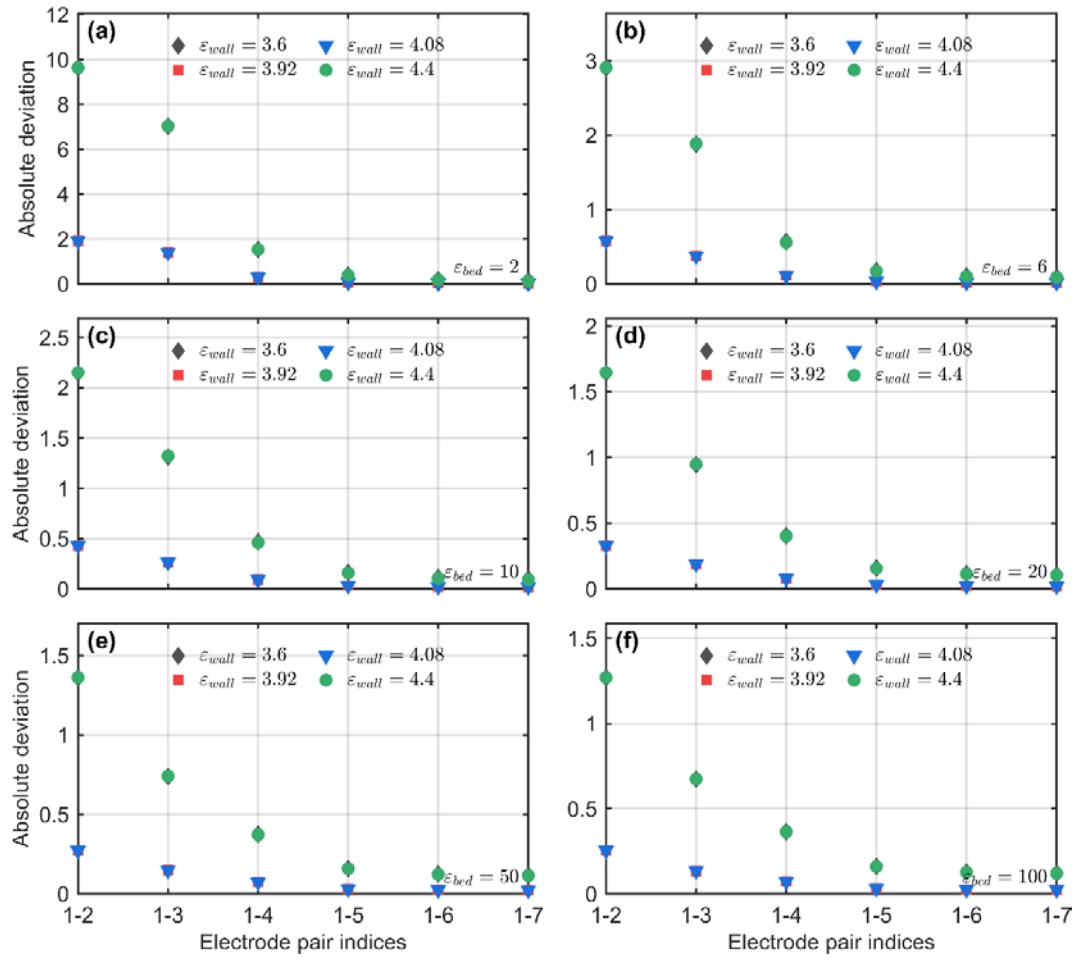


Fig. S9-4: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 27 mm outer diameter column with a 7.8 mm thickness.

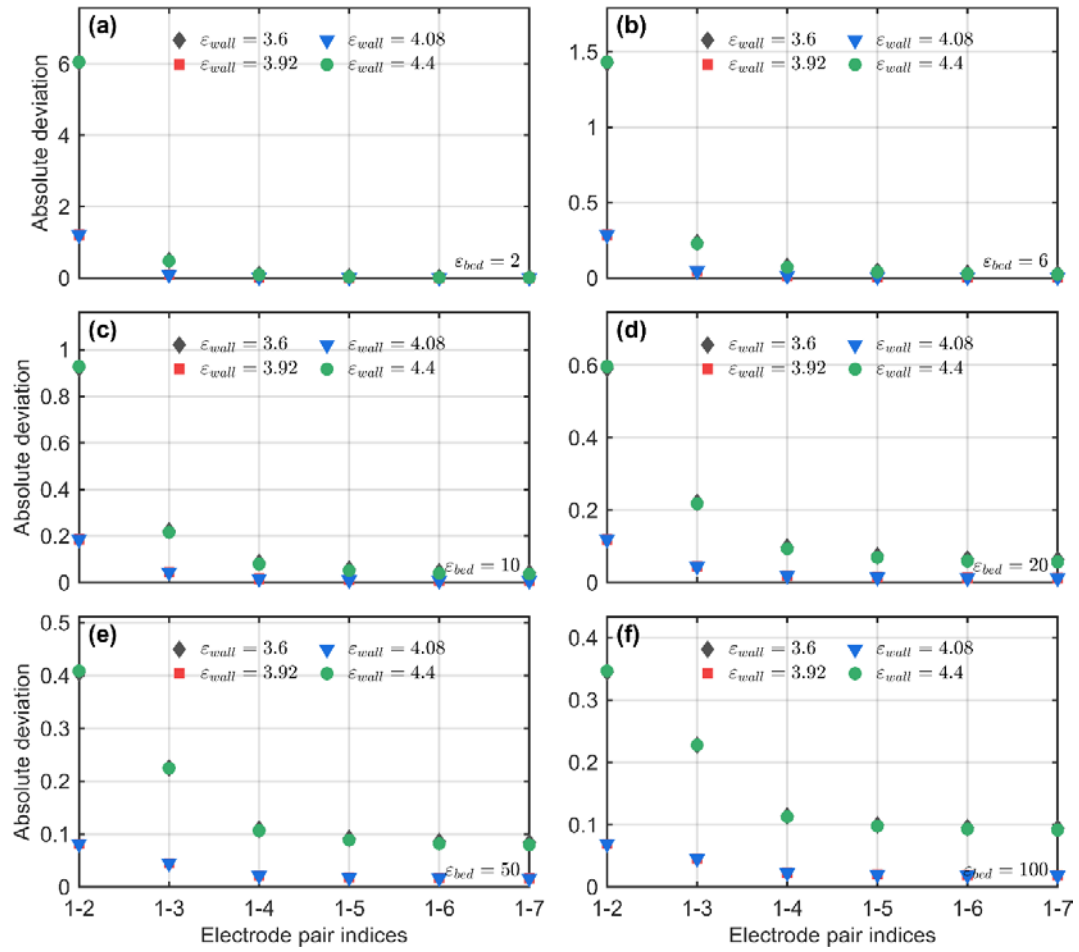


Fig. S10-1: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 114 mm outer diameter column with a 17.1 mm thickness.

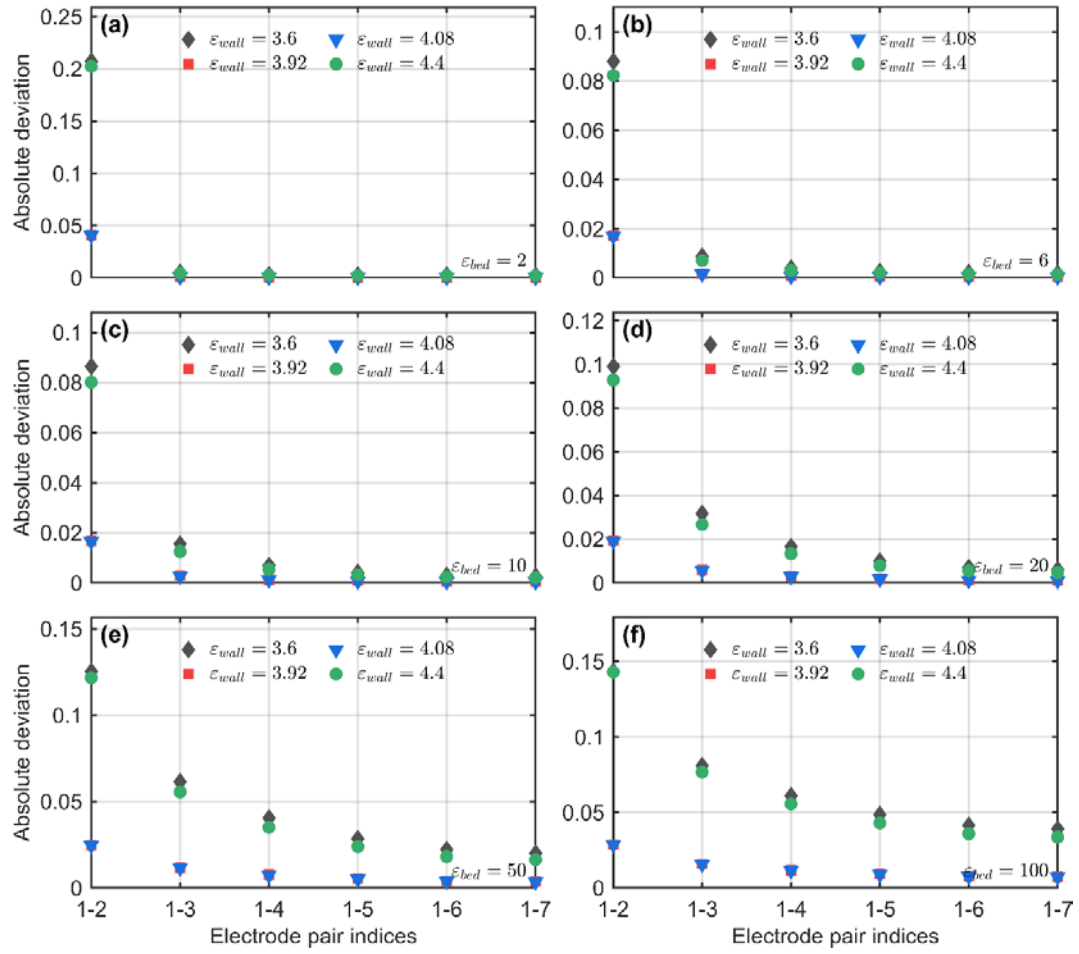


Fig. S10-2: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 114 mm outer diameter column with a 2.1 mm thickness.

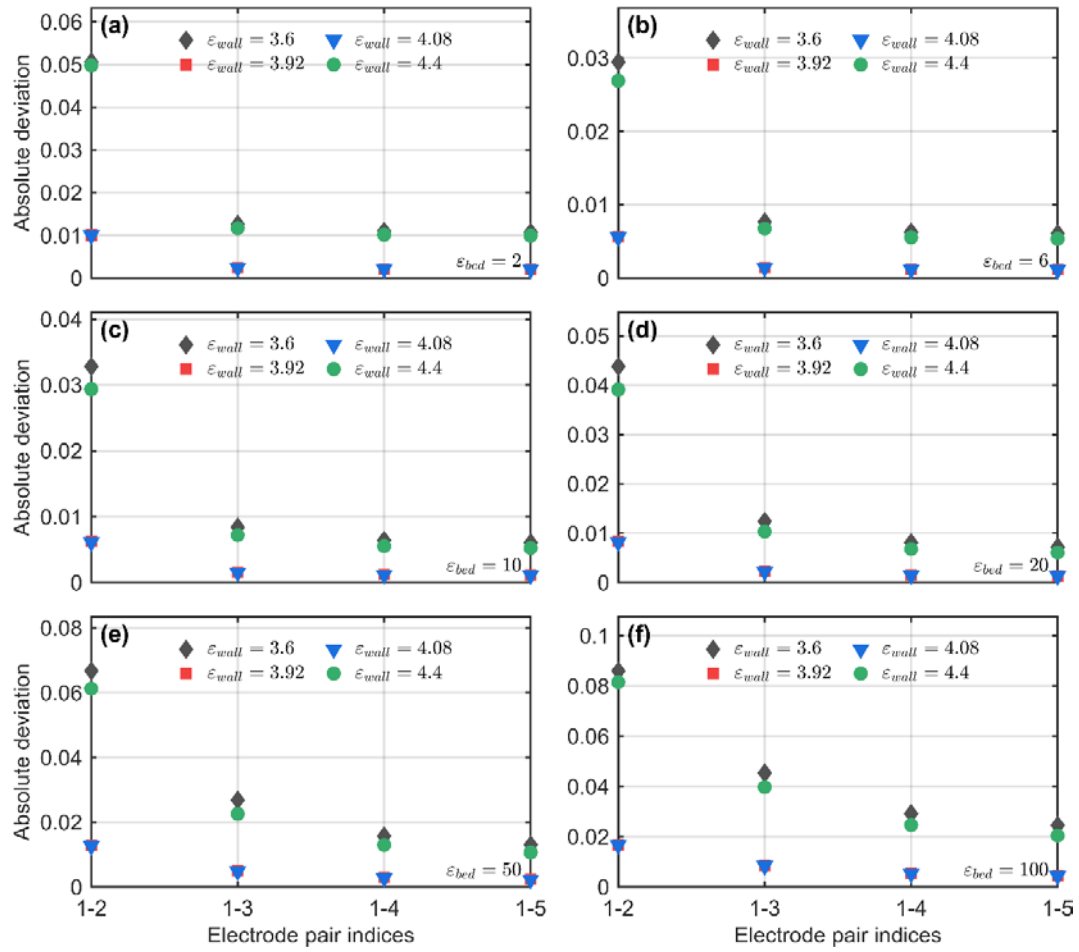


Fig. S11-1: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 9.5 mm thickness.

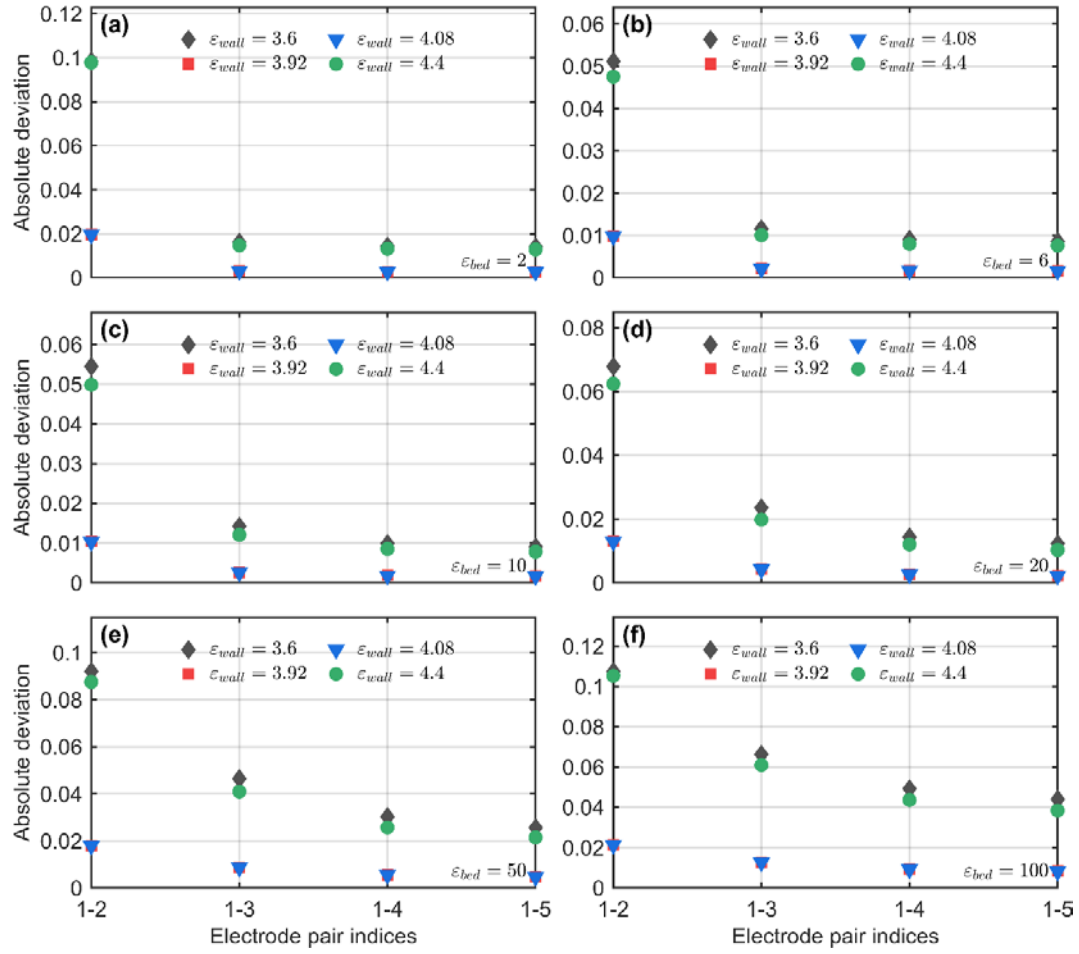


Fig. S11-2: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 19 mm thickness.

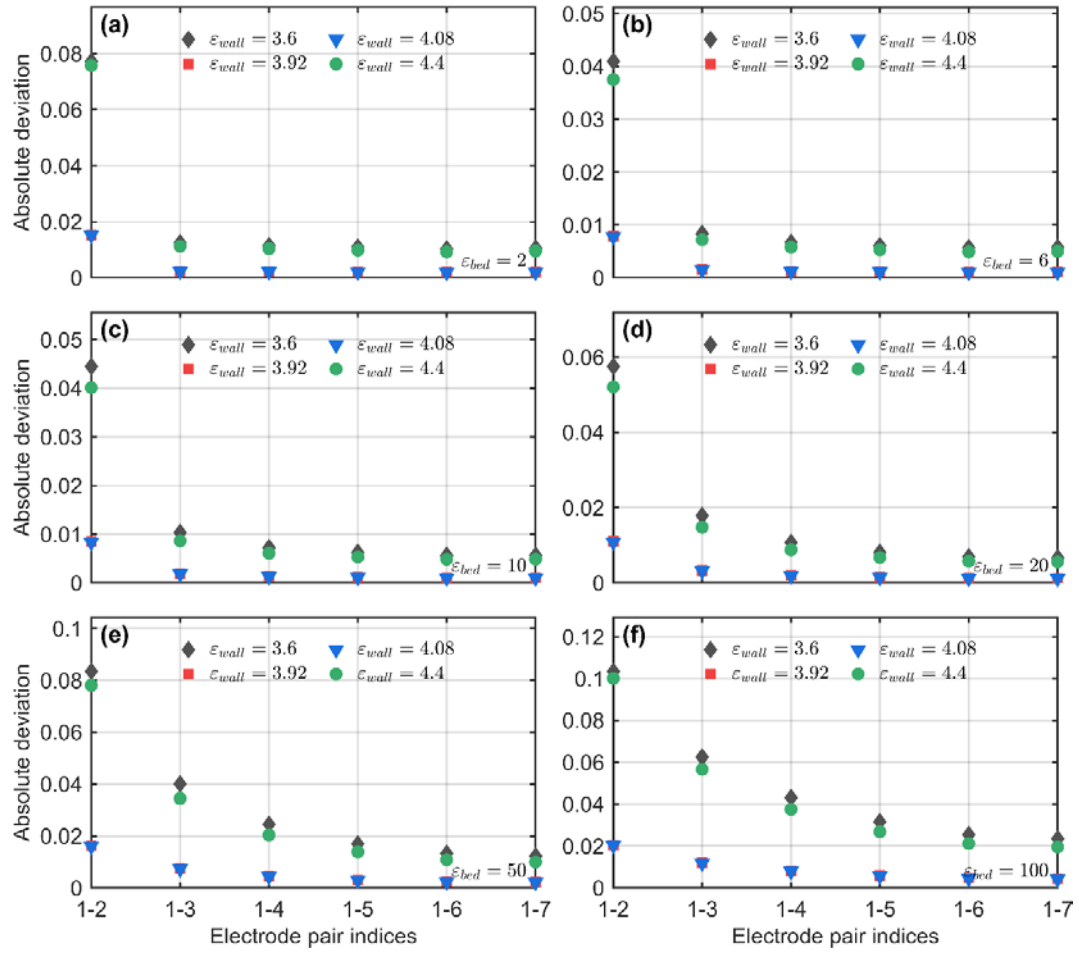


Fig. S11-3: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 9.5 mm thickness.

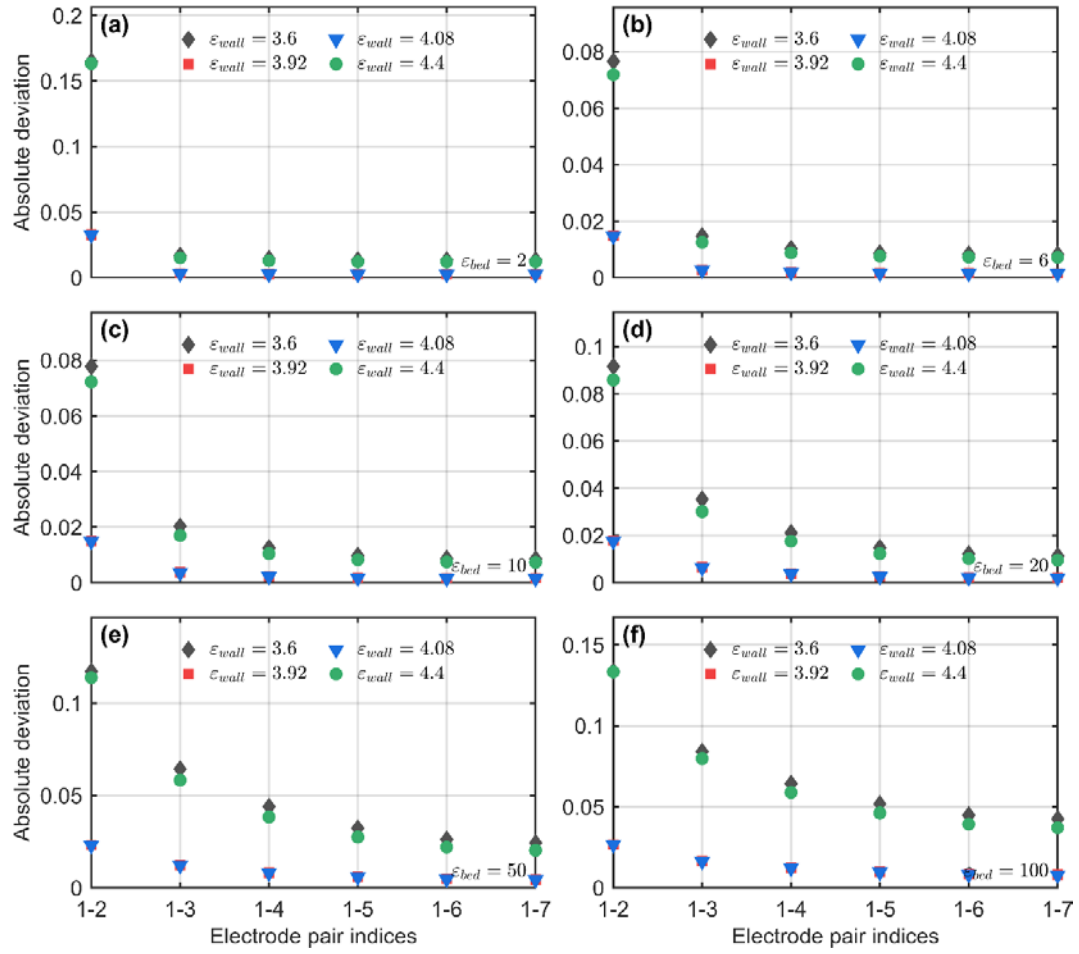


Fig. S11-4: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 19 mm thickness.

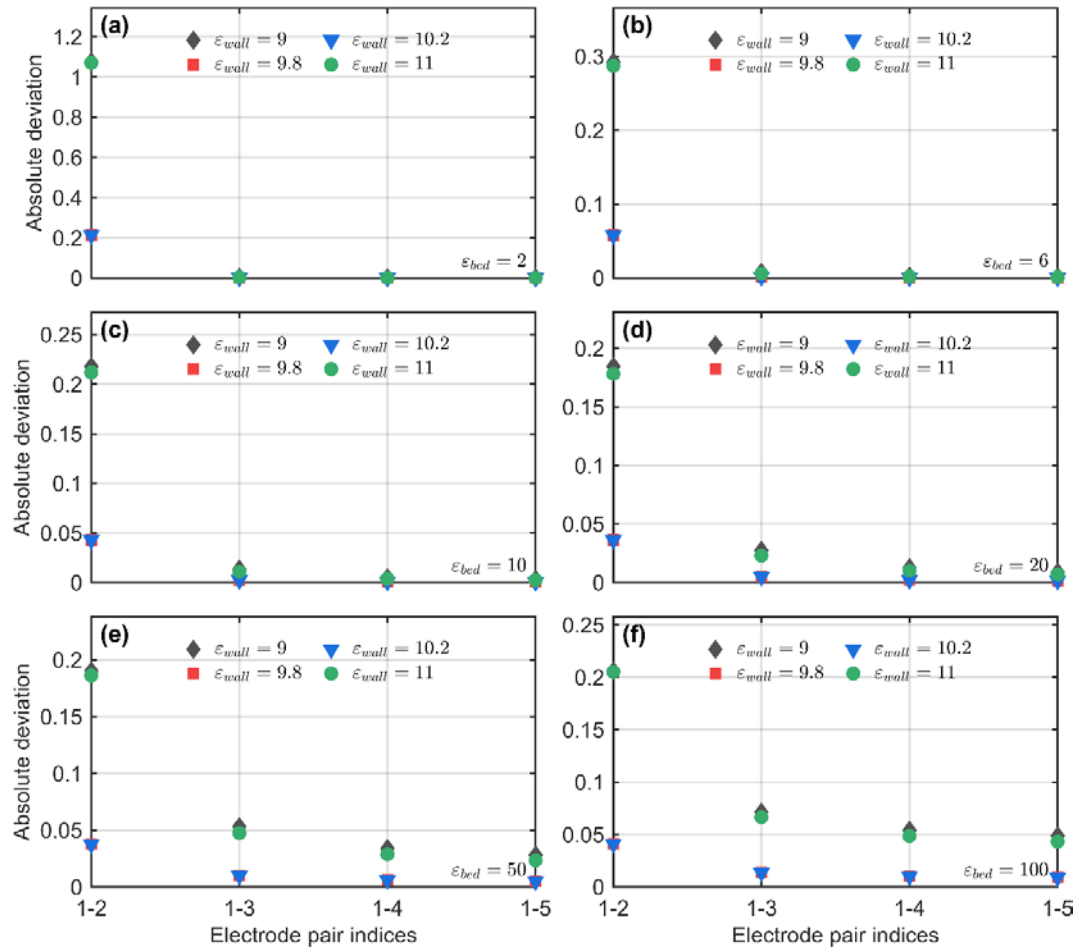


Fig. S12-1: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 27 mm outer diameter column with a 1.7 mm thickness.

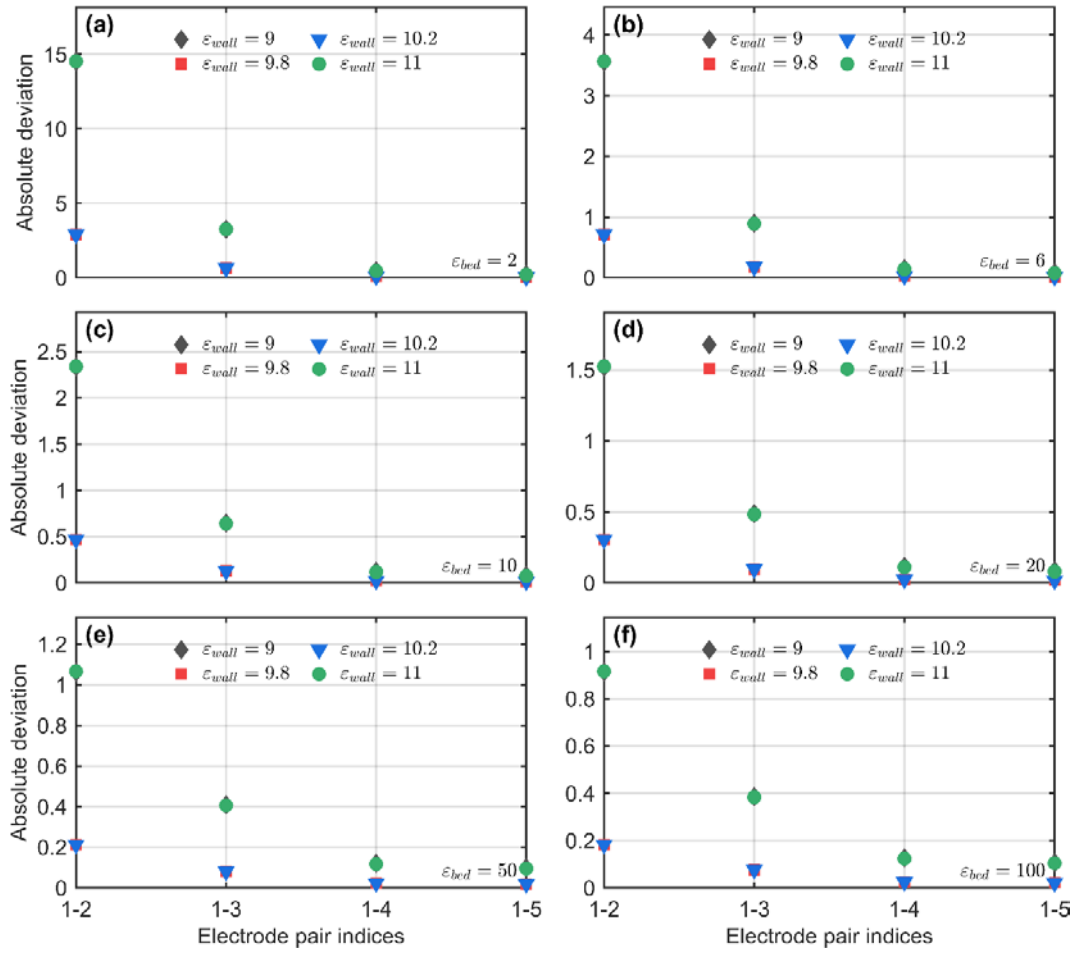


Fig. S12-2: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 27 mm outer diameter column with a 7.8 mm thickness.

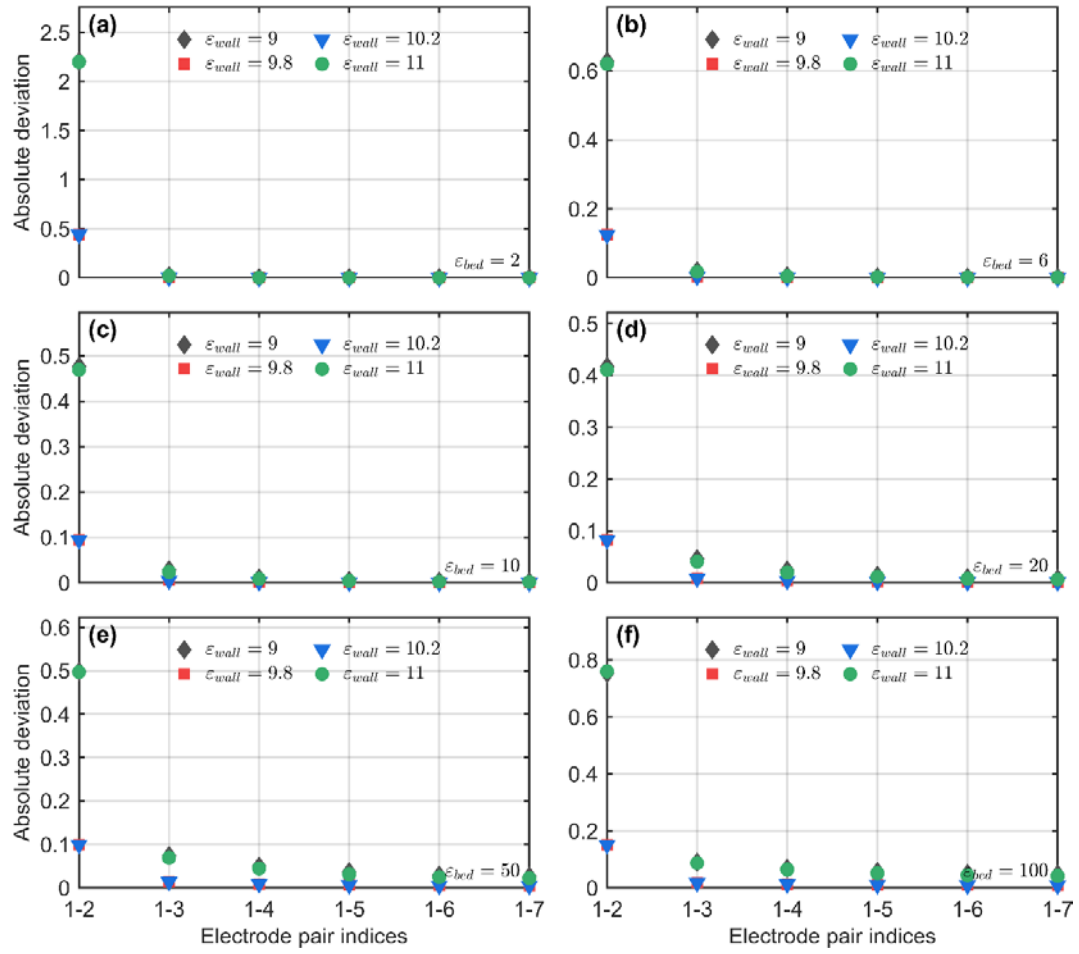


Fig. S12-3: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed}=2$, (b) $\epsilon_{bed}=6$, (c) $\epsilon_{bed}=10$, (d) $\epsilon_{bed}=20$, (e) $\epsilon_{bed}=50$, and (f) $\epsilon_{bed}=100$. 12-electrode ECT sensor mounted on a 27 mm outer diameter column with a 1.7 mm thickness.

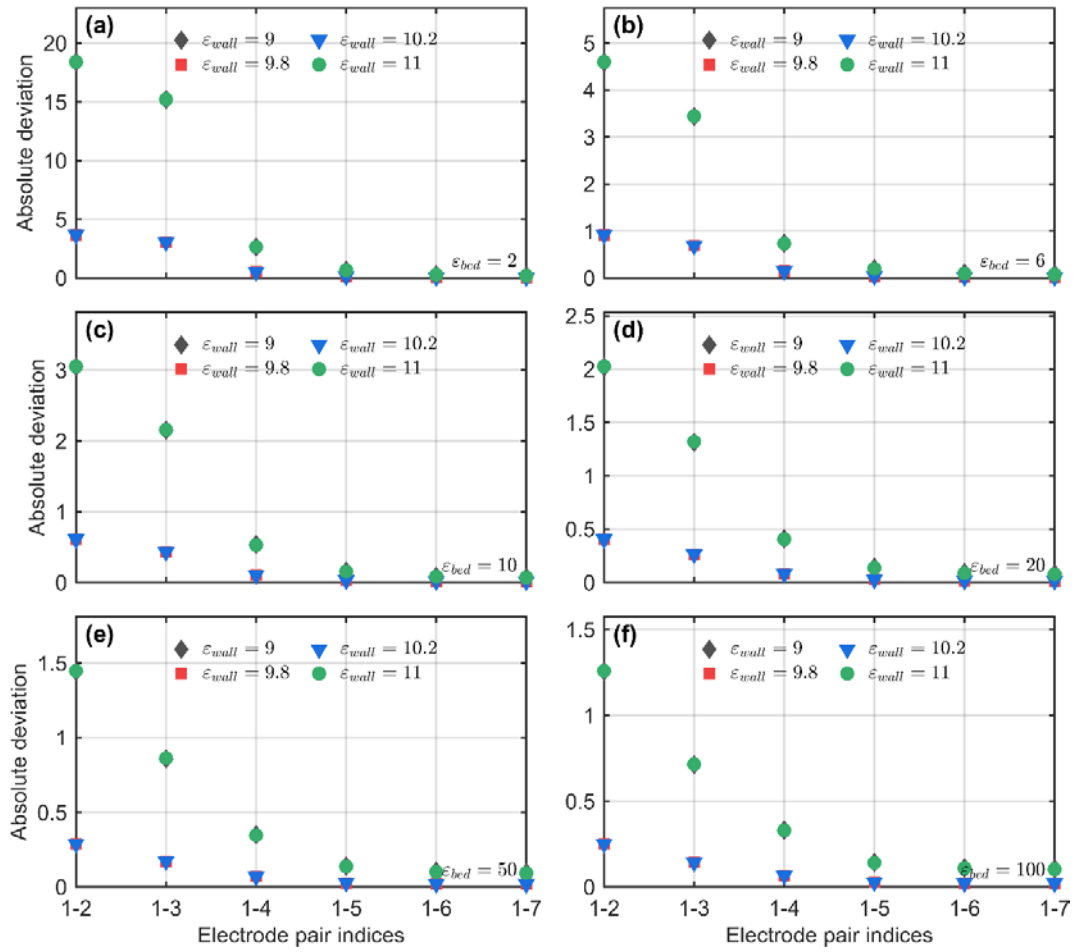


Fig. S12-4: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 27 mm outer diameter column with a 7.8 mm thickness.

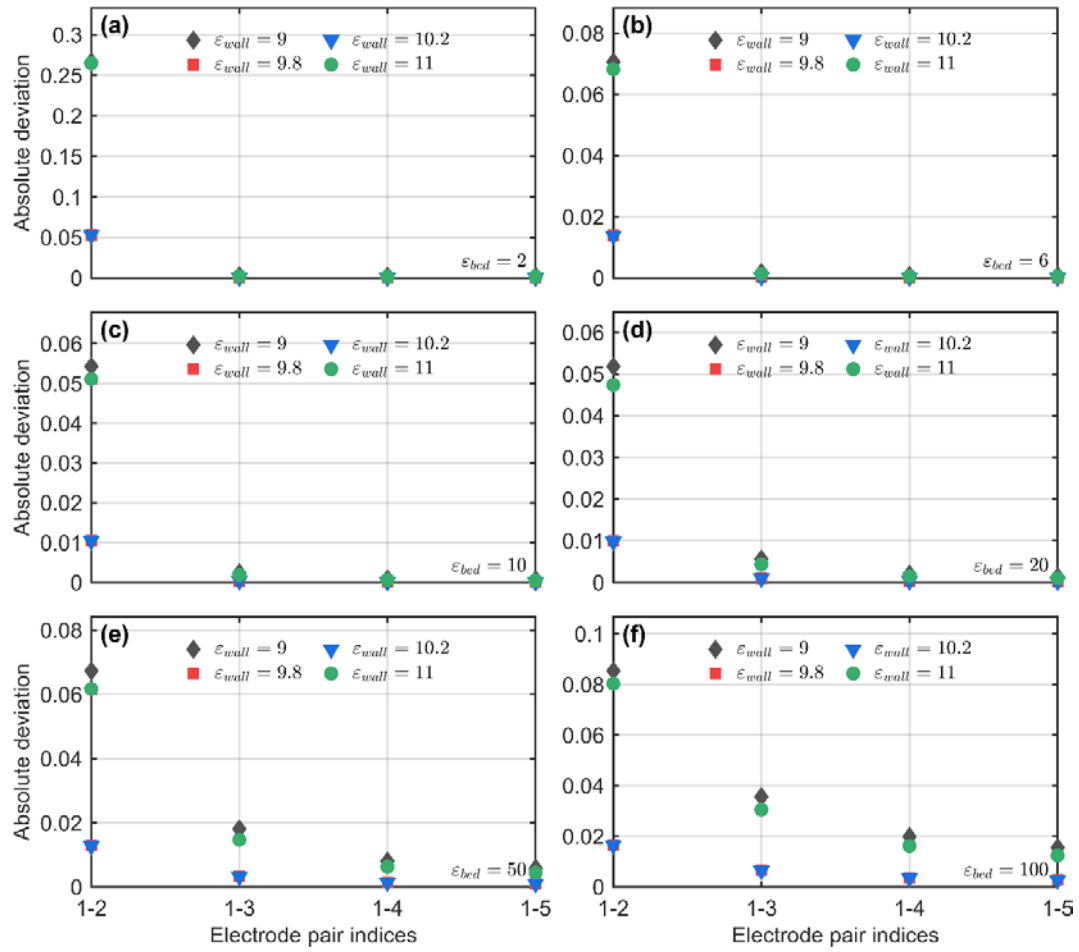


Fig. S13-1: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 114 mm outer diameter column with a 2.1 mm thickness.

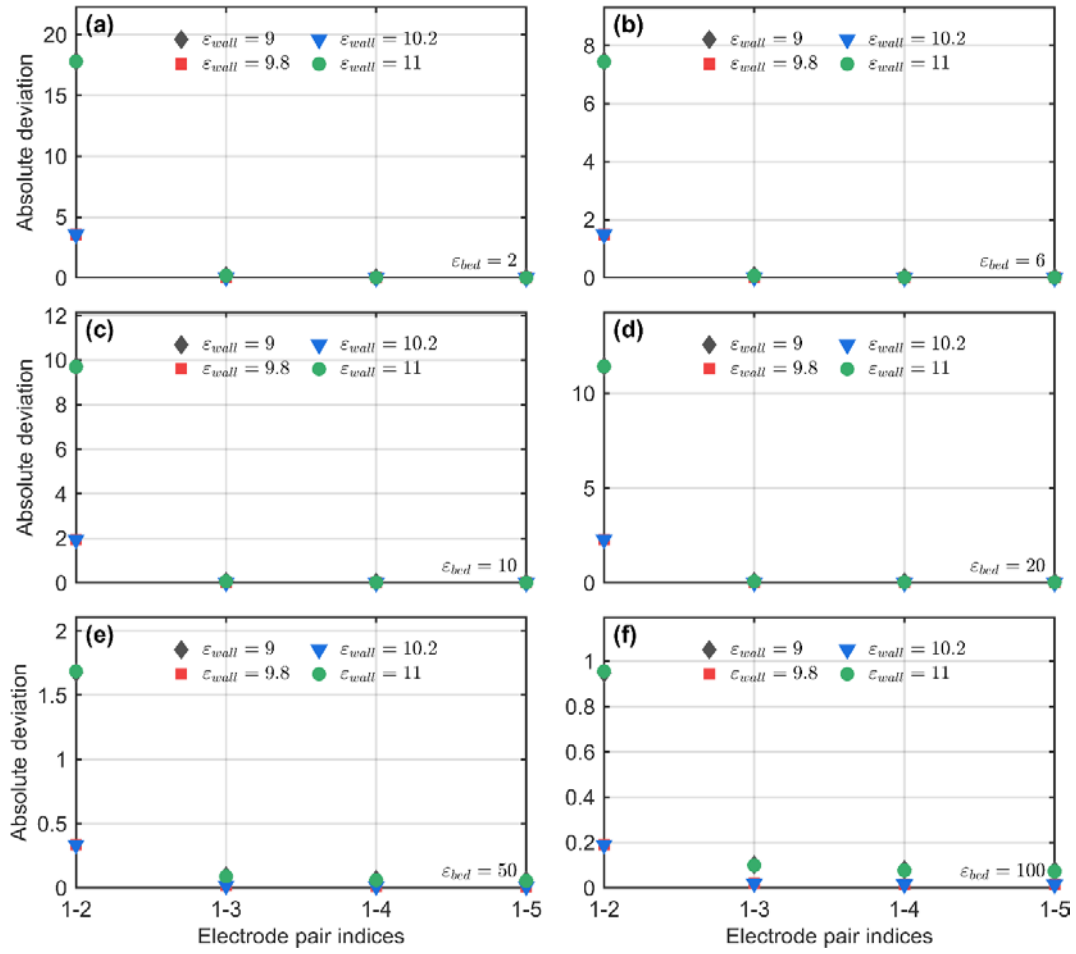


Fig. S13-2: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 114 mm outer diameter column with a 17.1 mm thickness.

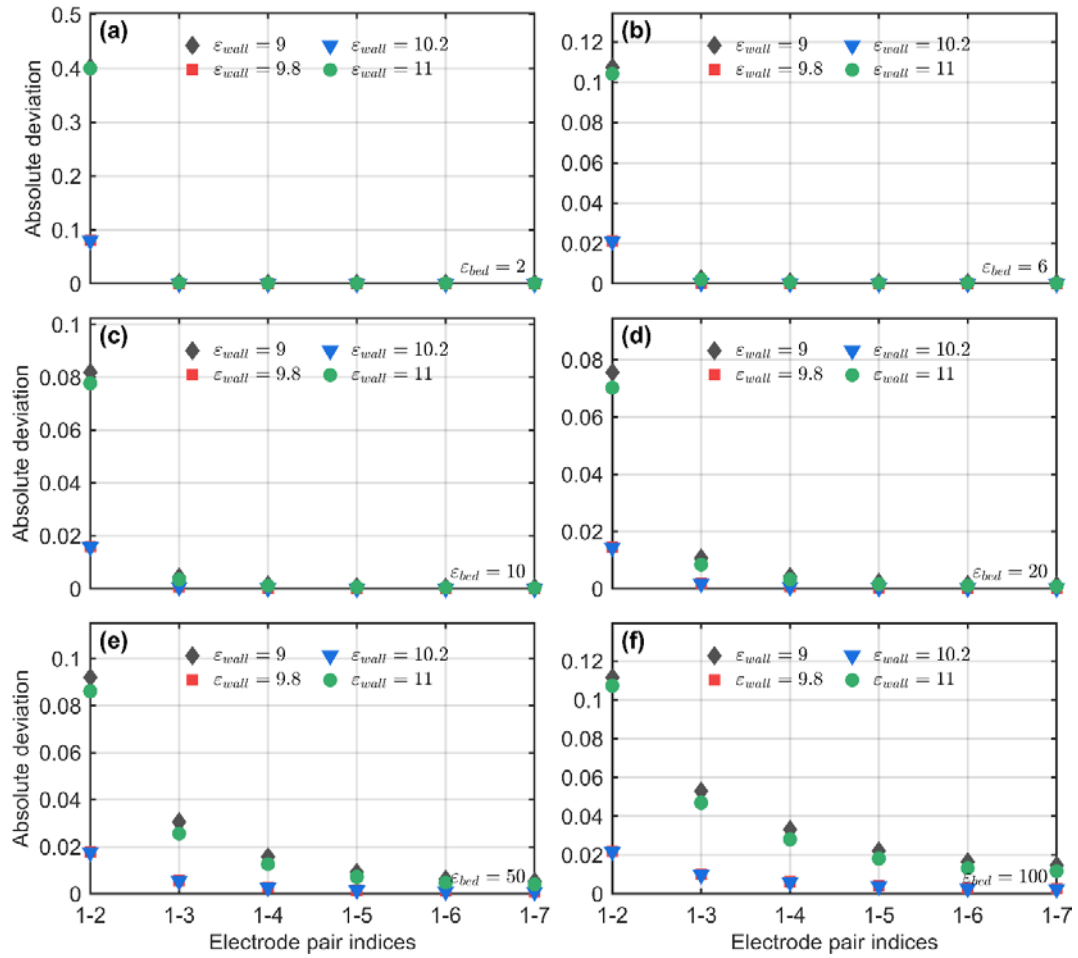


Fig. S13-3: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed}=2$, (b) $\epsilon_{bed}=6$, (c) $\epsilon_{bed}=10$, (d) $\epsilon_{bed}=20$, (e) $\epsilon_{bed}=50$, and (f) $\epsilon_{bed}=100$. 12-electrode ECT sensor mounted on a 114 mm outer diameter column with a 2.1 mm thickness.

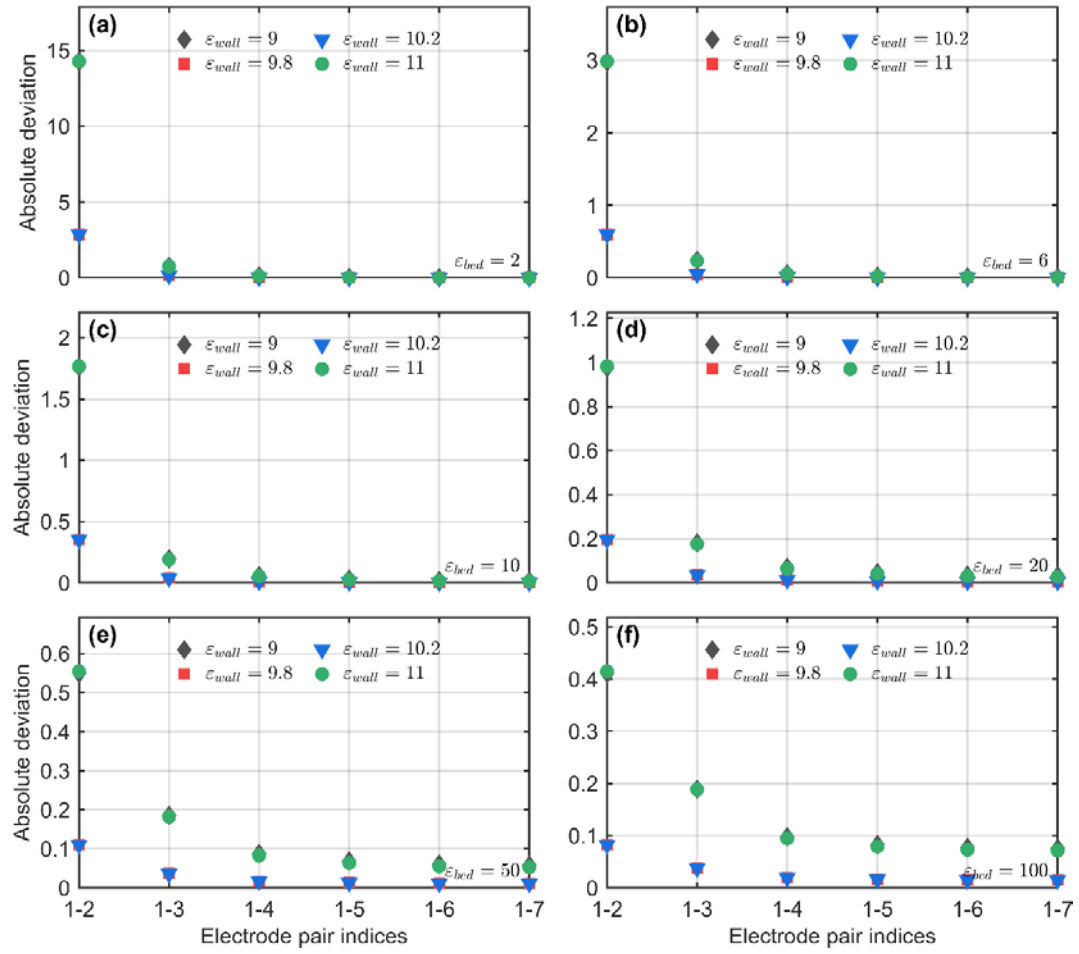


Fig. S13-4: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 114 mm outer diameter column with a 17.1 mm thickness.

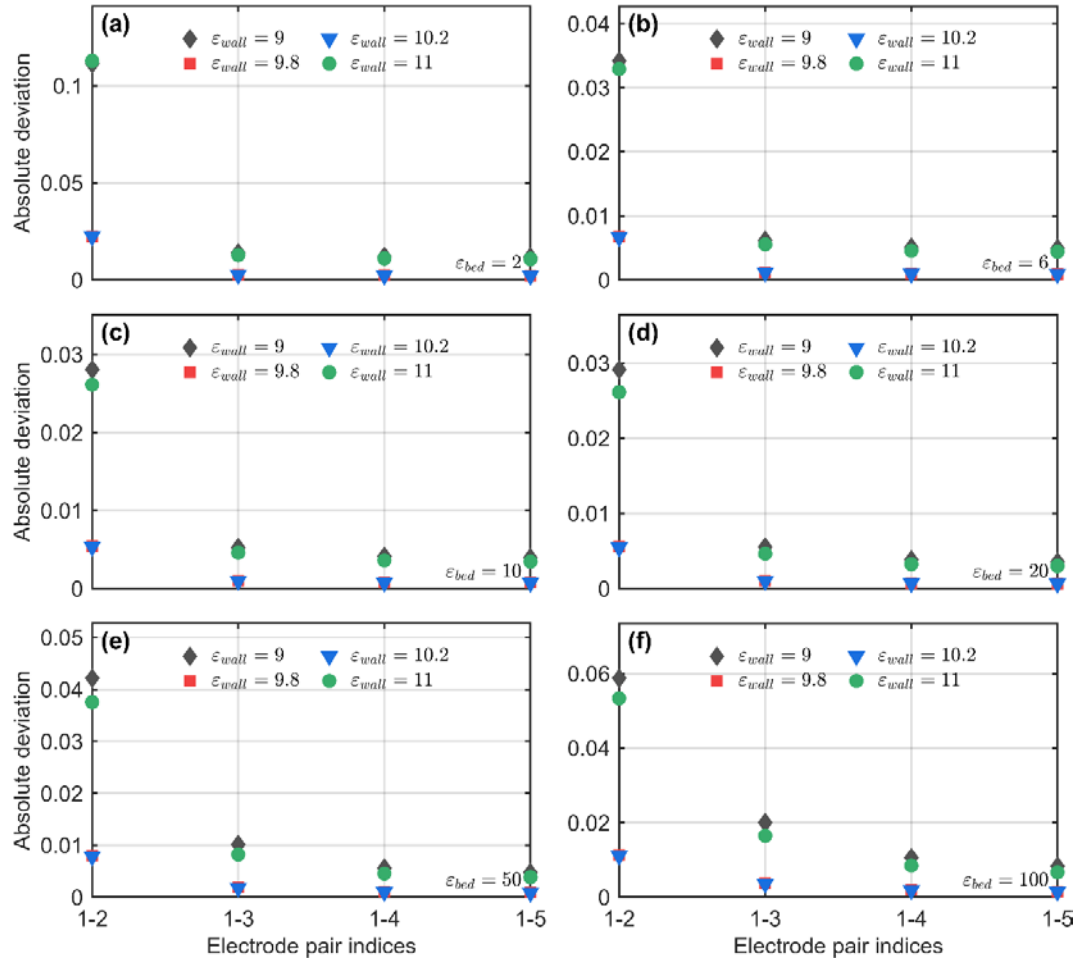


Fig. S14-1: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 9.5 mm thickness.

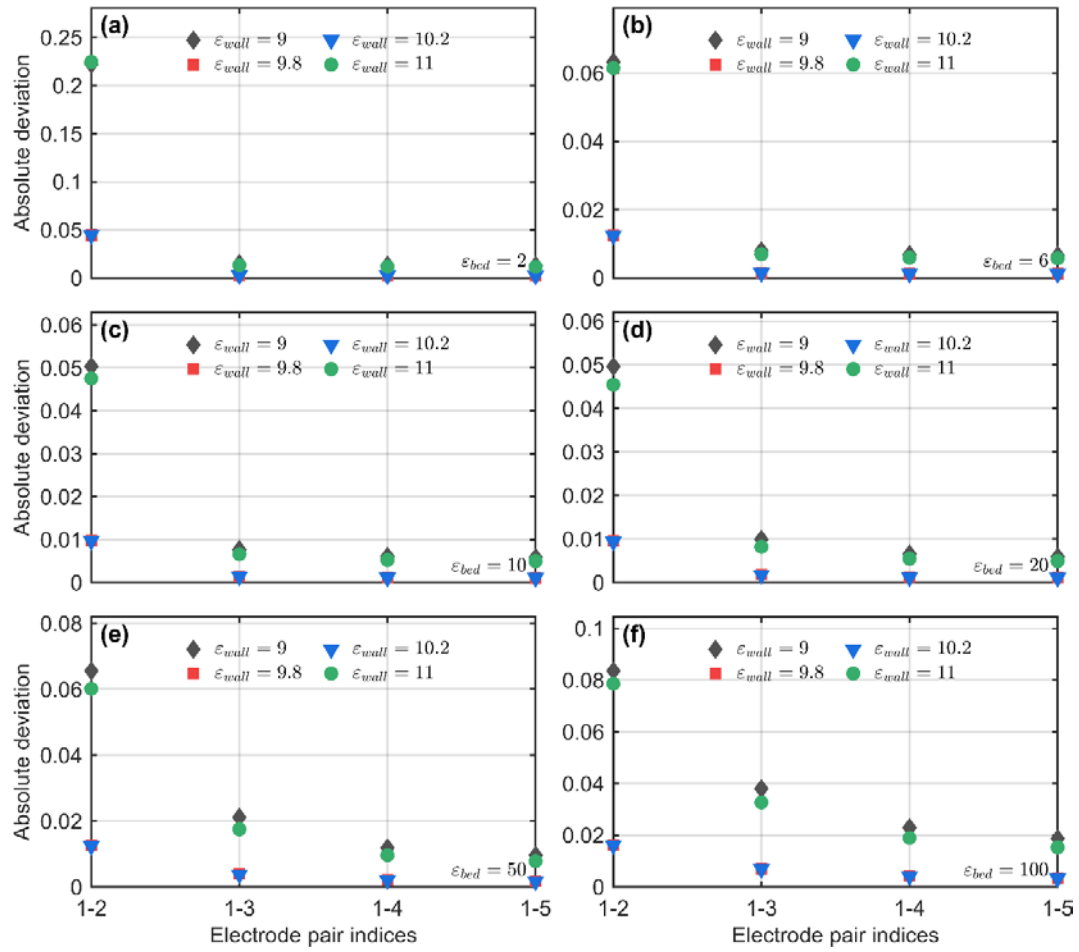


Fig. S14-2: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 8-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 19 mm thickness.

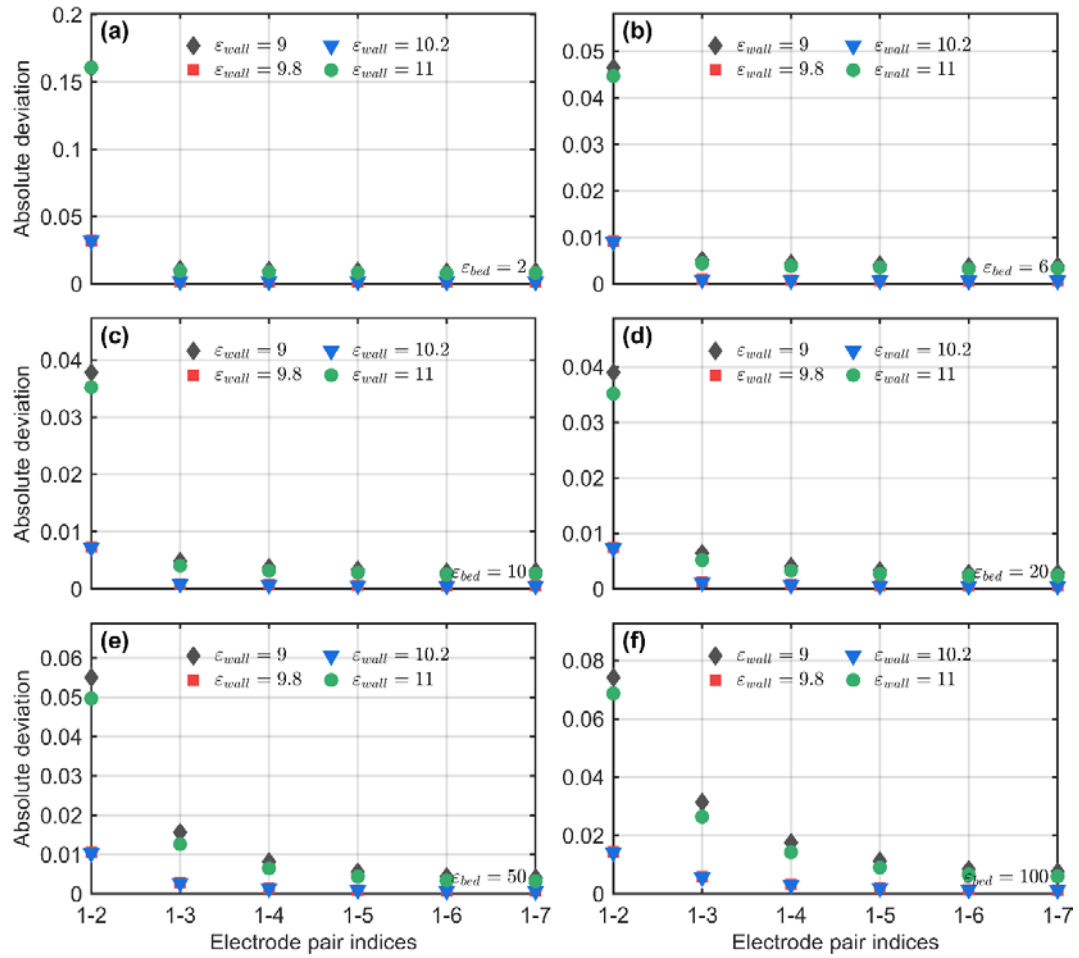


Fig. S14-3: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 9.5 mm thickness.

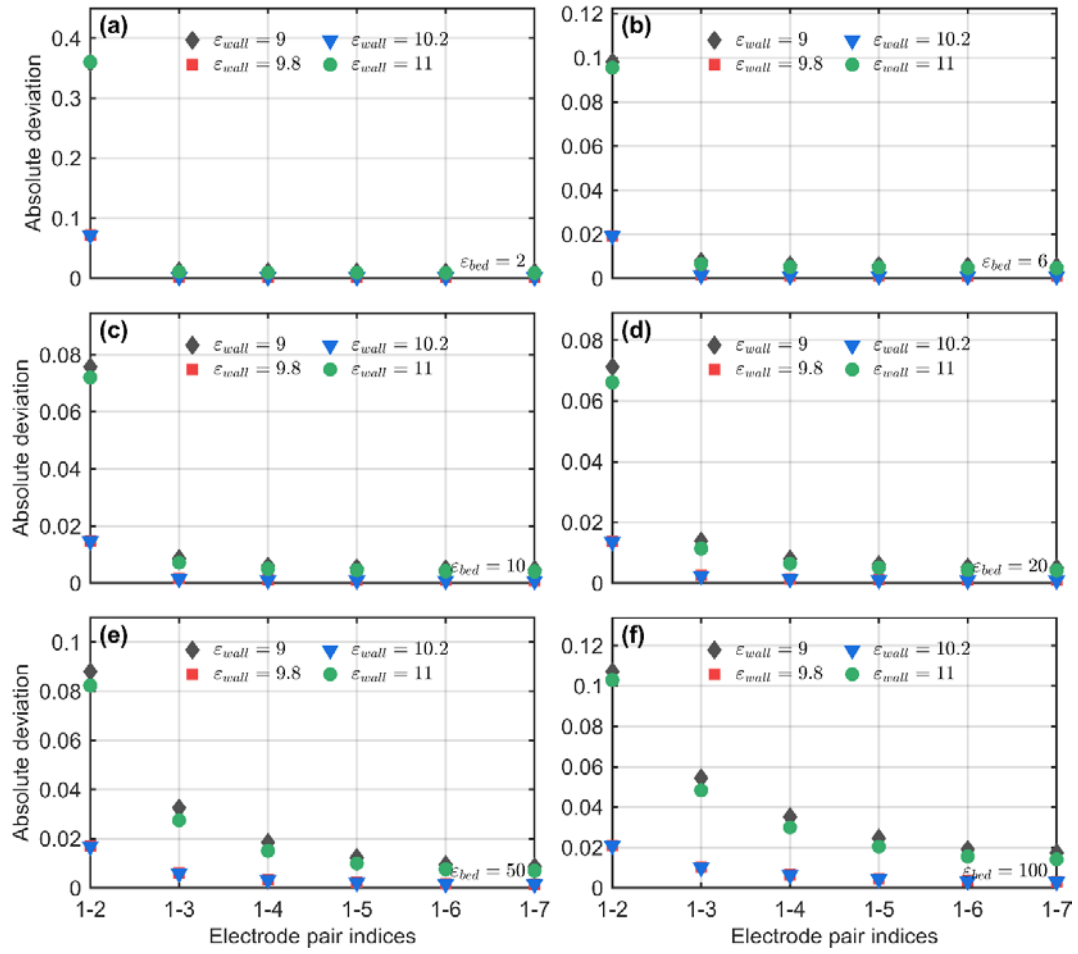


Fig. S14-4: Absolute deviations in normalized capacitance between the reference wall permittivity ($\epsilon_{wall} = 4$) and varied wall permittivities at different packed bed permittivities, (a) $\epsilon_{bed} = 2$, (b) $\epsilon_{bed} = 6$, (c) $\epsilon_{bed} = 10$, (d) $\epsilon_{bed} = 20$, (e) $\epsilon_{bed} = 50$, and (f) $\epsilon_{bed} = 100$. 12-electrode ECT sensor mounted on a 1067 mm outer diameter column with a 19 mm thickness.

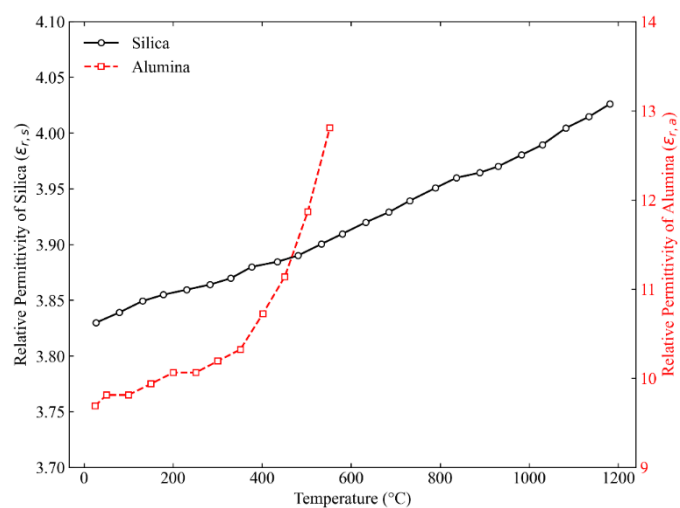


Figure S15. Temperature dependence of relative permittivity for silica and alumina (major components of FCC particles), extracted and re-plotted from literature data [32, 33].

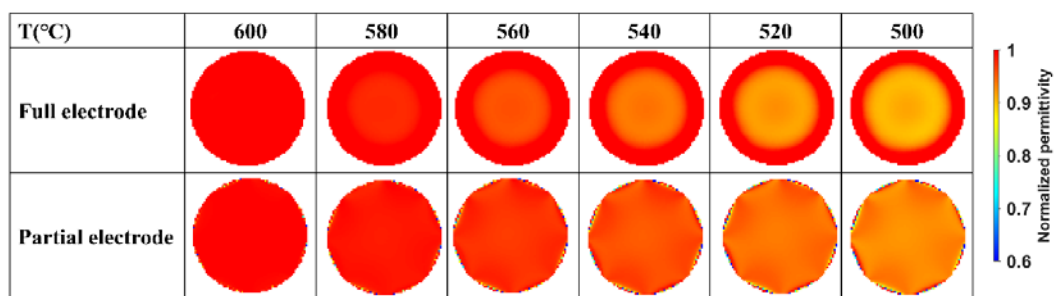


Figure S16. Comparison of reconstructed normalized permittivity for FCC particles with and without adjacent electrode measurements during the gradual cooling process from 600 °C to 500 °C.

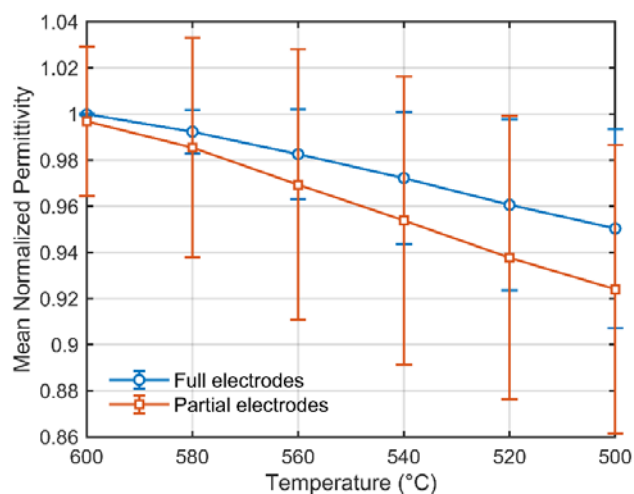


Figure S17. Comparison of the mean and standard deviation (error bar) of reconstructed normalized permittivity for FCC particles with and without adjacent electrode measurements during the gradual cooling process from 600 °C to 500 °C.

Table S1: Pearson's correlation coefficients of normalized sensitivity distributions with different permittivity of the wall, two different column thicknesses, and an outer diameter of 114 mm.

(a) Thickness: 17.1 mm				
ϵ_{wall}	4	2	10	100
12-electrode sensor	1	0.9906	0.9937	0.9809
8-electrode sensor	1	0.9900	0.9955	0.9876

(b) Thickness: 2.1 mm				
ϵ_{wall}	4	2	10	100
12-electrode sensor	1	0.9993	0.9996	0.9990
8-electrode sensor	1	0.9995	0.9997	0.9993

Table S2: Pearson's correlation coefficients of normalized sensitivity distributions with different permittivity of the wall, two different column thicknesses, and an outer diameter of 27 mm.

(a) Thickness:1.7 mm				
ϵ_{wall}	4	2	10	100
12-electrode sensor	1	0.9940	0.9974	0.9930
8-electrode sensor	1	0.9973	0.9988	0.9966

(b) Thickness:7.8 mm				
ϵ_{wall}	4	2	10	100
12-electrode sensor	1	0.9958	0.9970	0.9907
8-electrode sensor	1	0.9998	0.9998	0.9995

Table S3: Correlation coefficients of normalized sensitivity distributions with different permittivity of the gap. Outer diameter: 114 mm, thickness: 17.1 mm, $\epsilon_{wall} = 4$.

Permittivity of gap material	4	2	10	100
12-electrode sensor	1	1	1	1
8-electrode sensor	1	1	1	1

Table S4. Diagnostic threshold matrix linking the equivalent signal-to-noise ratio (SNR_{dB}), the tolerable absolute deviation threshold (D_T), and the statistically guaranteed image reconstruction accuracies (Probability ≥ 0.995) via the adaptive projected Landweber iteration algorithm with 200 iterations.

SNR_{dB}	Deviation (D_T)	Pearson correlation coefficient (R_g)		Relative error of each pixel (RD_{g_i})		Relative error of each frame ($RD_{\bar{g}}$)	
		8-Ele	12-Ele	8-Ele	12-Ele	8-Ele	12-Ele
30	0.0316	-	-	-	-	<5.0%	<2.0%
40	0.0100	-	-	-	-	<2.0%	<0.4%
50	0.0032	>0.80	-	< 5.0%	<5.0%	<0.5%	<0.2%
60	0.0010	>0.96	>0.94	<2.0%	<1.5%	<0.2%	<0.1%