

Supplemental Material
for
Analytical modeling and decoupling of humidity effects in nanomechanical
sensing based on sorption kinetics and viscoelastic stress relaxation

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(Dated: April 28, 2025)

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S I. SUPPLEMENTARY FIGURES

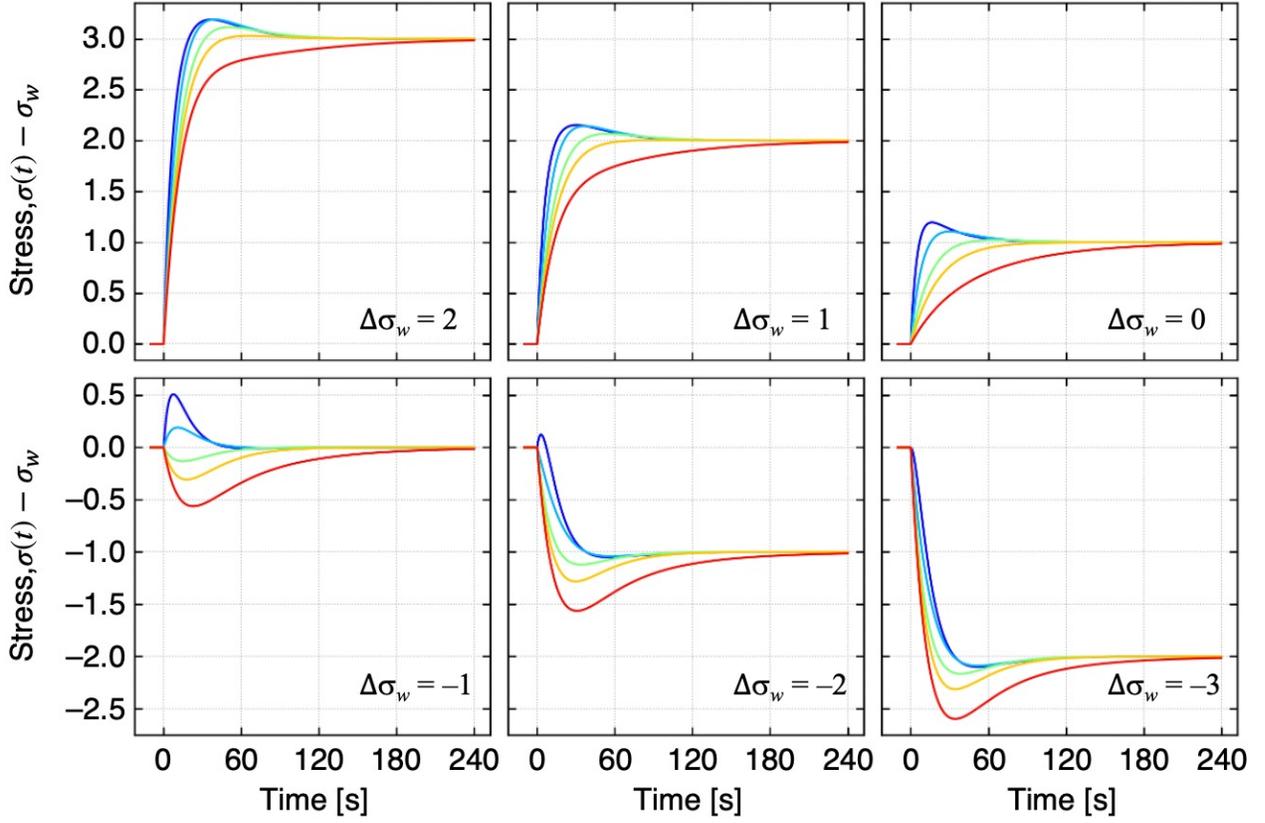


FIG. S1. Numerical calculations of the signal responses for a single injection using derived model in eq 7. Offset responses $\sigma(t) - \sigma_w$ to analytes with different τ_s with varied humidity differences $\Delta\sigma_w = 2, 1, 0, -1, -2,$ and -3 . Colors indicate the different τ_s : blue, $\tau_s = 5$ [s]; sky blue, $\tau_s = 10$ [s]; green, $\tau_s = 20$ [s]; yellow, $\tau_s = 30$ [s]; red, $\tau_s = 60$ [s].

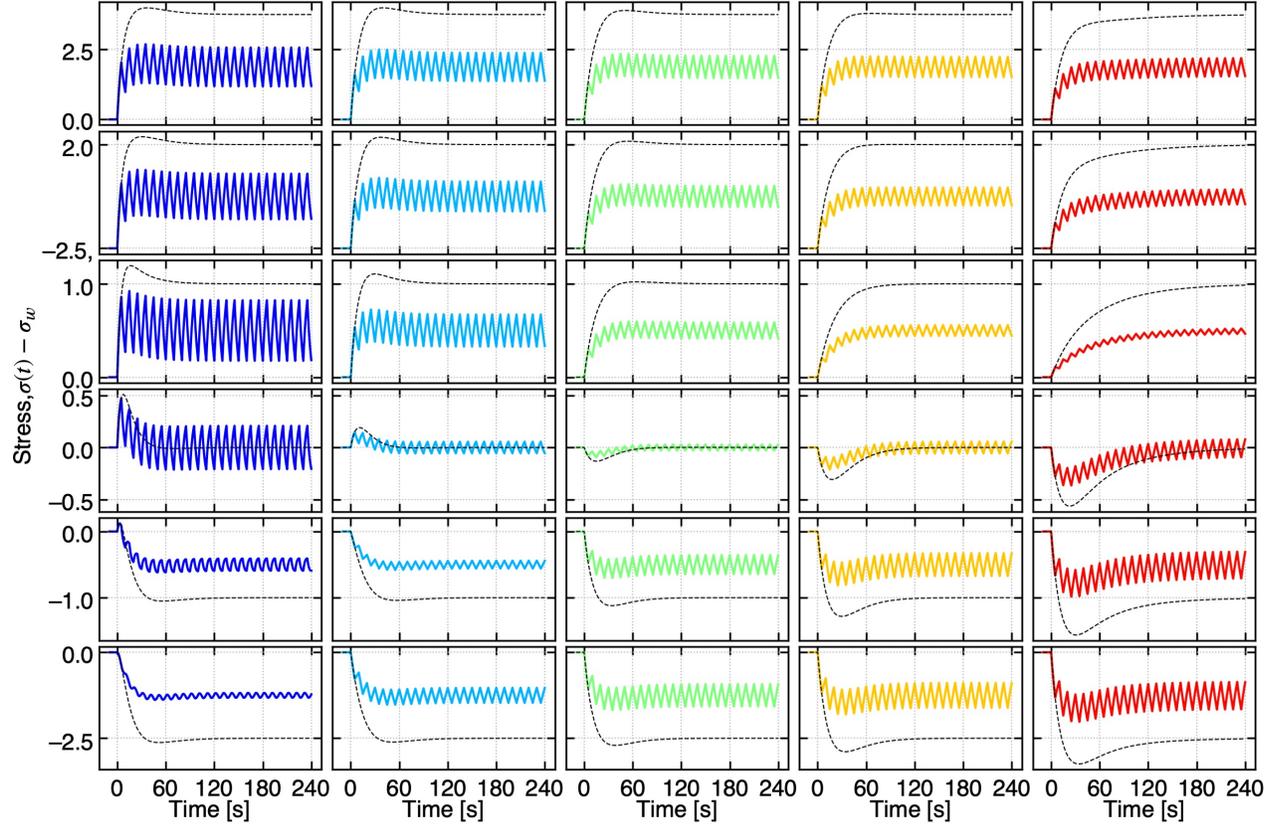


FIG. S2. Numerical calculations of the signal responses for multistep injection-purge cycles using derived model in eq 7. Offset responses $\sigma(t) - \sigma_w$ to analytes with different s with varied humidity differences $\Delta\sigma_w$. Colors indicate the different τ_s : blue, $\tau_s = 5$ [s]; sky blue, $\tau_s = 10$ [s]; green, $\tau_s = 20$ [s]; yellow, $\tau_s = 30$ [s]; red, $\tau_s = 60$ [s].

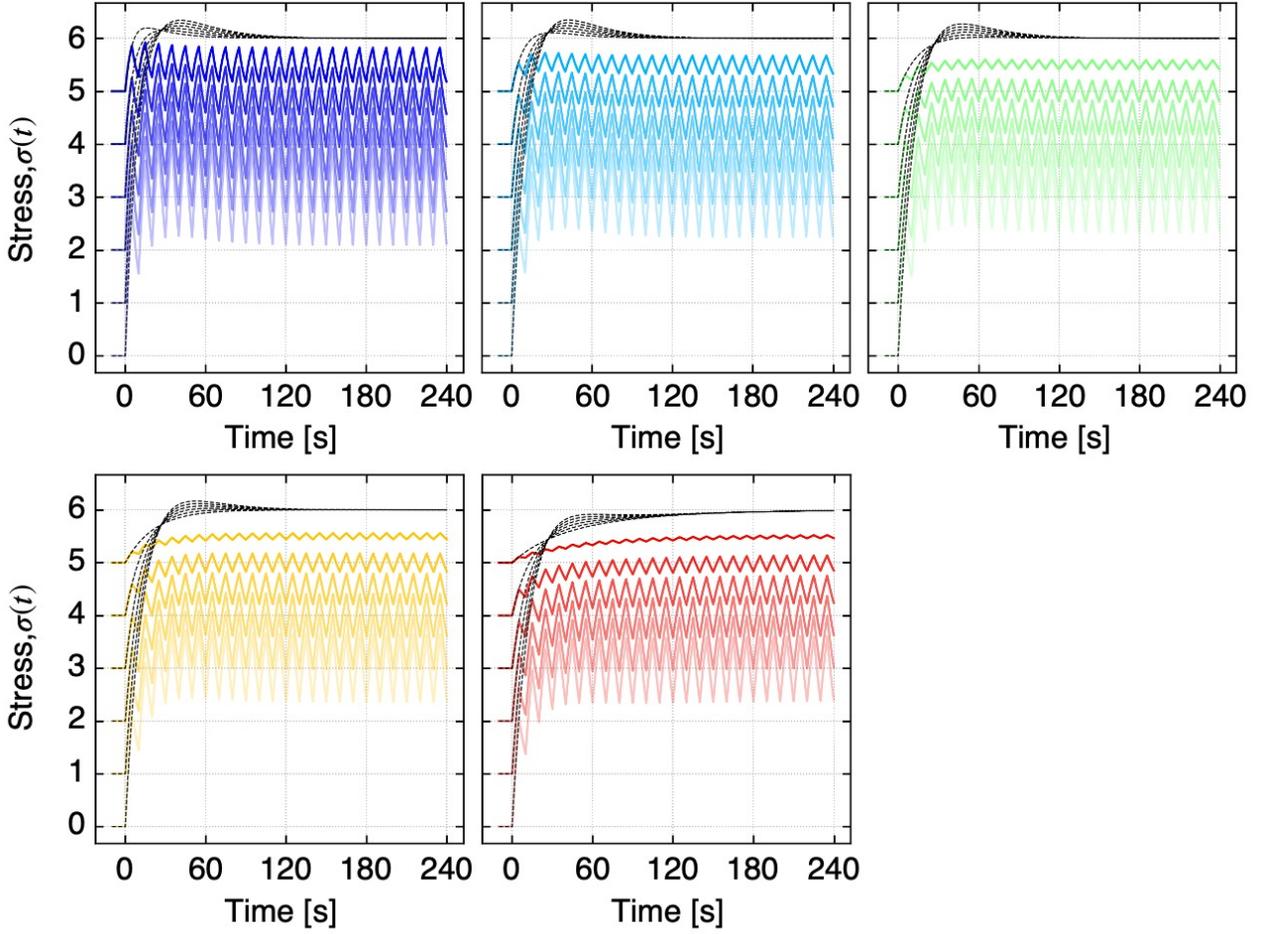


FIG. S3. Numerical calculations of the signal responses for multistep injection-purge cycles using derived model in eq 7. Model responses to highly humidified analytes, i.e., fixed $\sigma_w + \Delta\sigma_w = 6$, under varied initial humidity $C_w \propto \sigma_w$ with different τ_s . Colors indicate the different τ_s : blue, $\tau_s = 5$ [s]; sky blue, $\tau_s = 10$ [s]; green, $\tau_s = 20$ [s]; yellow, $\tau_s = 30$ [s]; red, $\tau_s = 60$ [s].

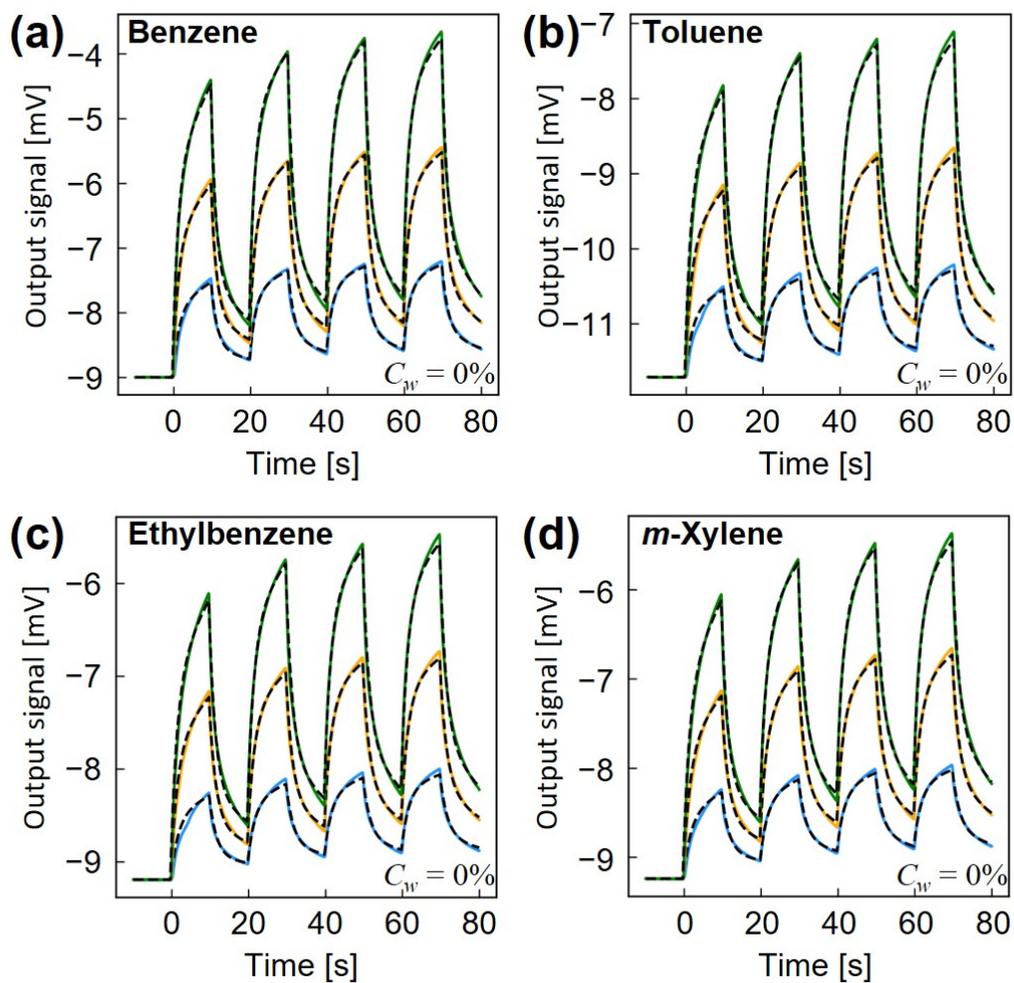


FIG. S4. Responses to pure BTEX at the different concentrations. The output signals are shown as solid lines, while the predicted responses based on the extracted fitting parameters are represented by dashed lines. (a) benzene, (b) toluene, (c) ethylbenzene, and (d) *m*-xylene. Analyte concentrations are indicated by colors: 5%, blue; 10%, orange; and 15%, green.

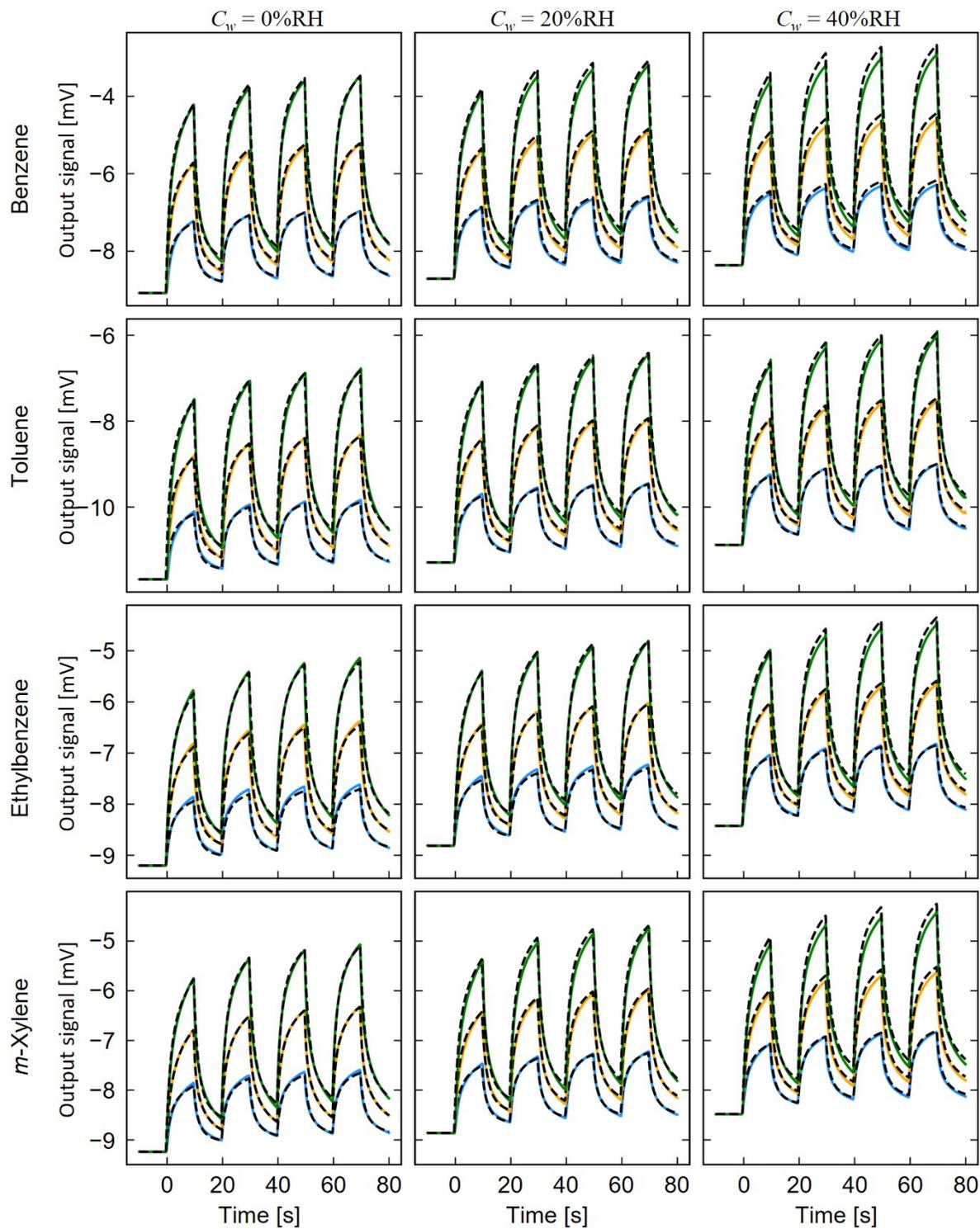


FIG. S5. Responses to BETX at different concentrations under $\Delta C_w = 20\%RH$; the initial humidity level C_w from left to right are $C_w = 0, 20,$ and $40\%RH$. Analyte concentrations are indicated by colors: 5%, blue; 10%, orange; and 15%, green, with predicted responses based on the extracted fitting parameters shown as dashed lines.

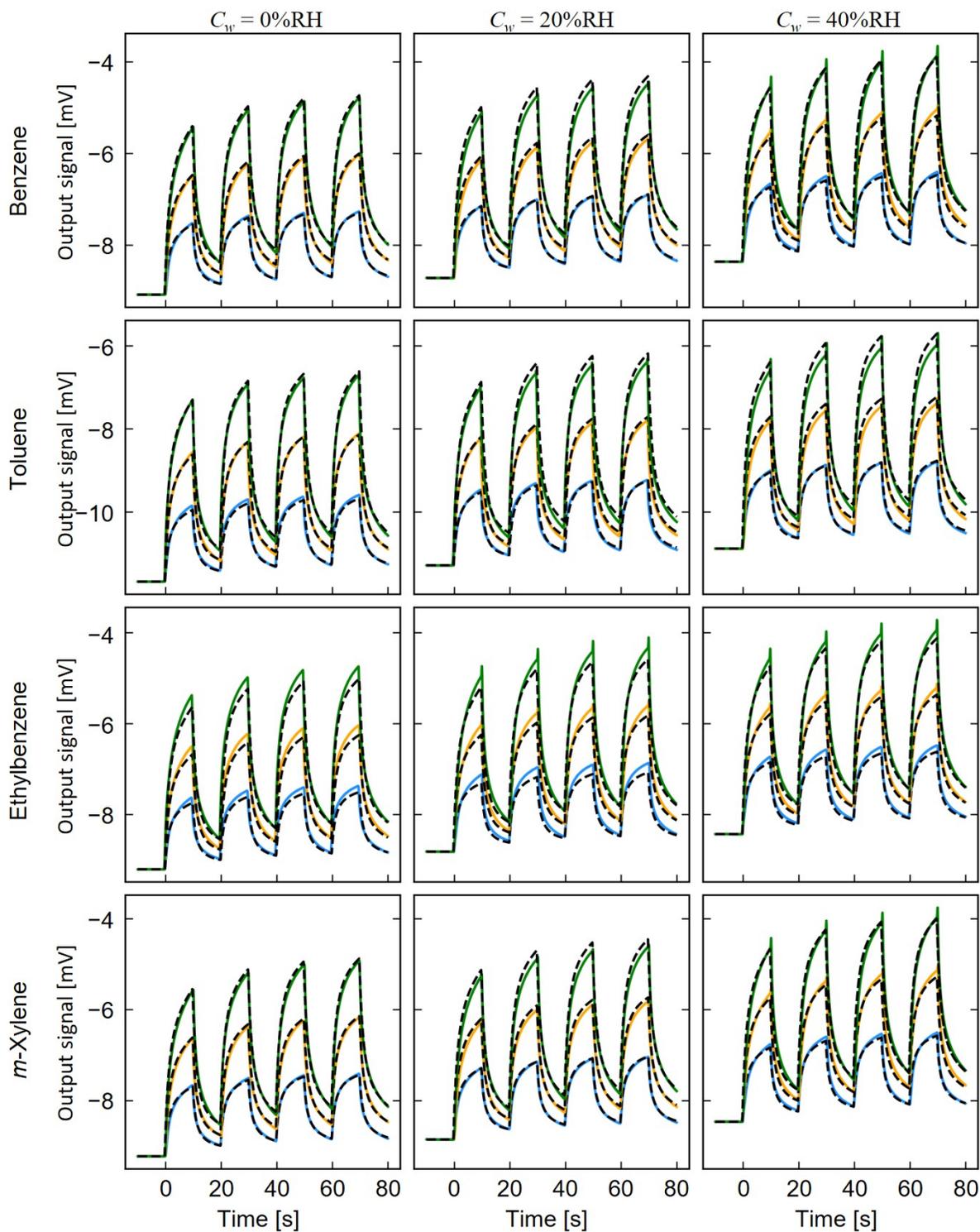


FIG. S6. Responses to BETX at different concentrations under $\Delta C_w = 30\%RH$; the initial humidity level C_w from left to right are $C_w = 0, 20,$ and $40\%RH$. Analyte concentrations are indicated by colors: 5%, blue; 10%, orange; and 15%, green, with predicted responses based on the extracted fitting parameters shown as dashed lines.

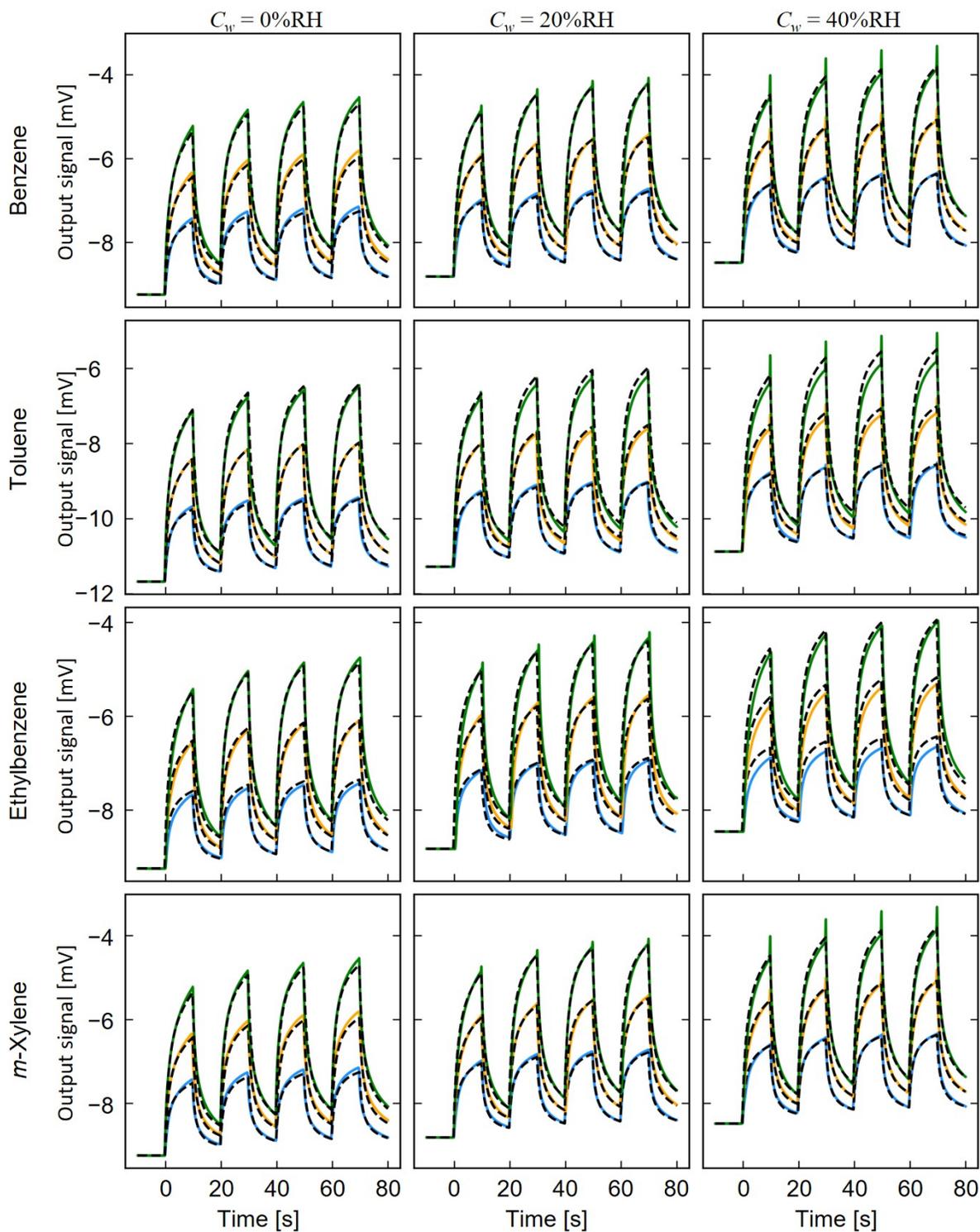


FIG. S7. Responses to BETX at different concentrations under $\Delta C_w = 40\%RH$; the initial humidity level C_w from left to right are $C_w = 0, 20,$ and $40\%RH$. Analyte concentrations are indicated by colors: 5%, blue; 10%, orange; and 15%, green, with predicted responses based on the extracted fitting parameters shown as dashed lines.

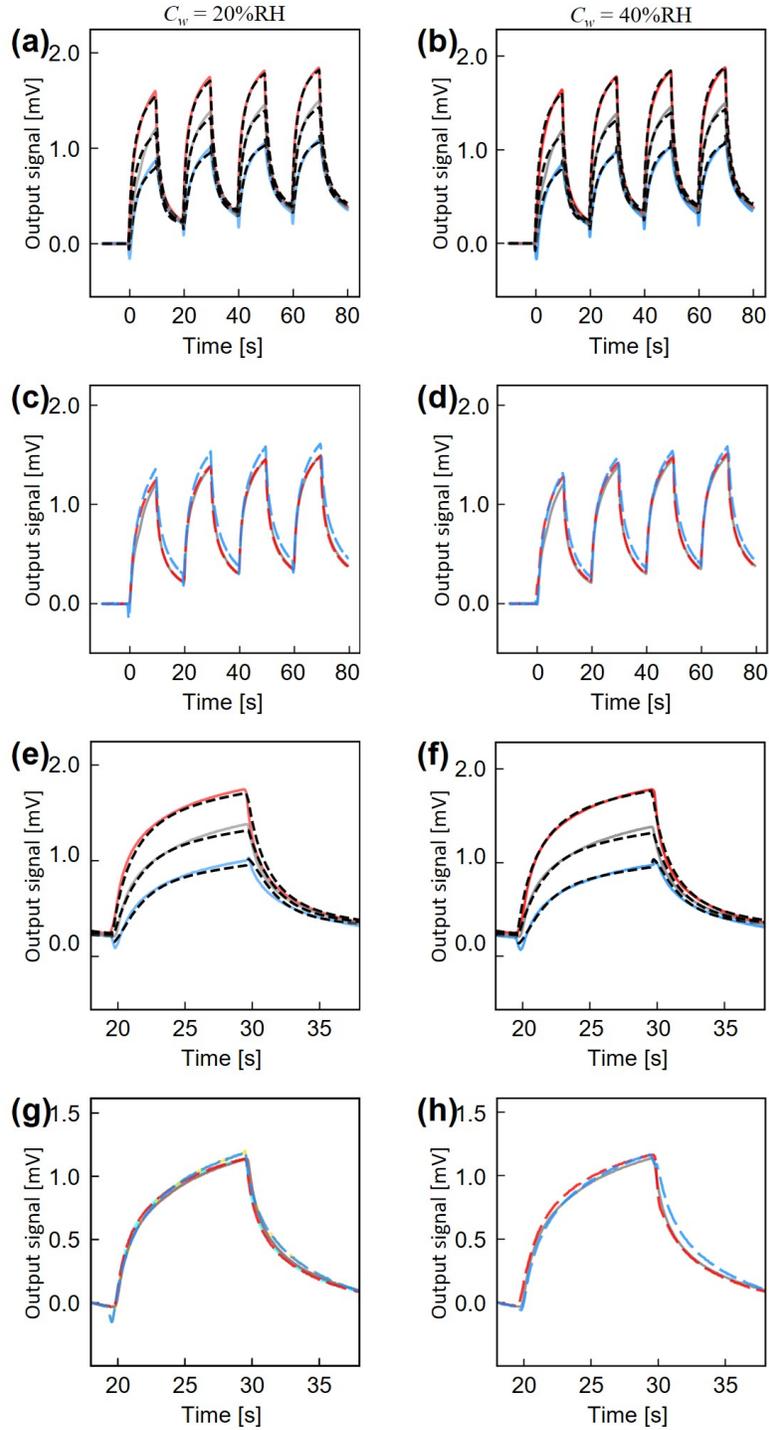


FIG. S8. Responses to toluene under positive and negative humidity changes ($\Delta C_w = \pm 20\%RH$). a,b) The responses to toluene vapor at $C_g = 5\%$ under positive (red; $\Delta C_w = 20\%RH$) and negative humidity changes (blue; $\Delta C_w = -20\%RH$). c,d) Subtracted signals. Gray, pure toluene; red dashed lines, $\Delta C_w = 20\%RH$; blue dashed lines, $\Delta C_w = -20\%RH$. e,f) Magnified responses from 20 to 40 s. g,h) Subtracted signals. See also Fig. S11 for comparison between the pure signal and subtracted responses.

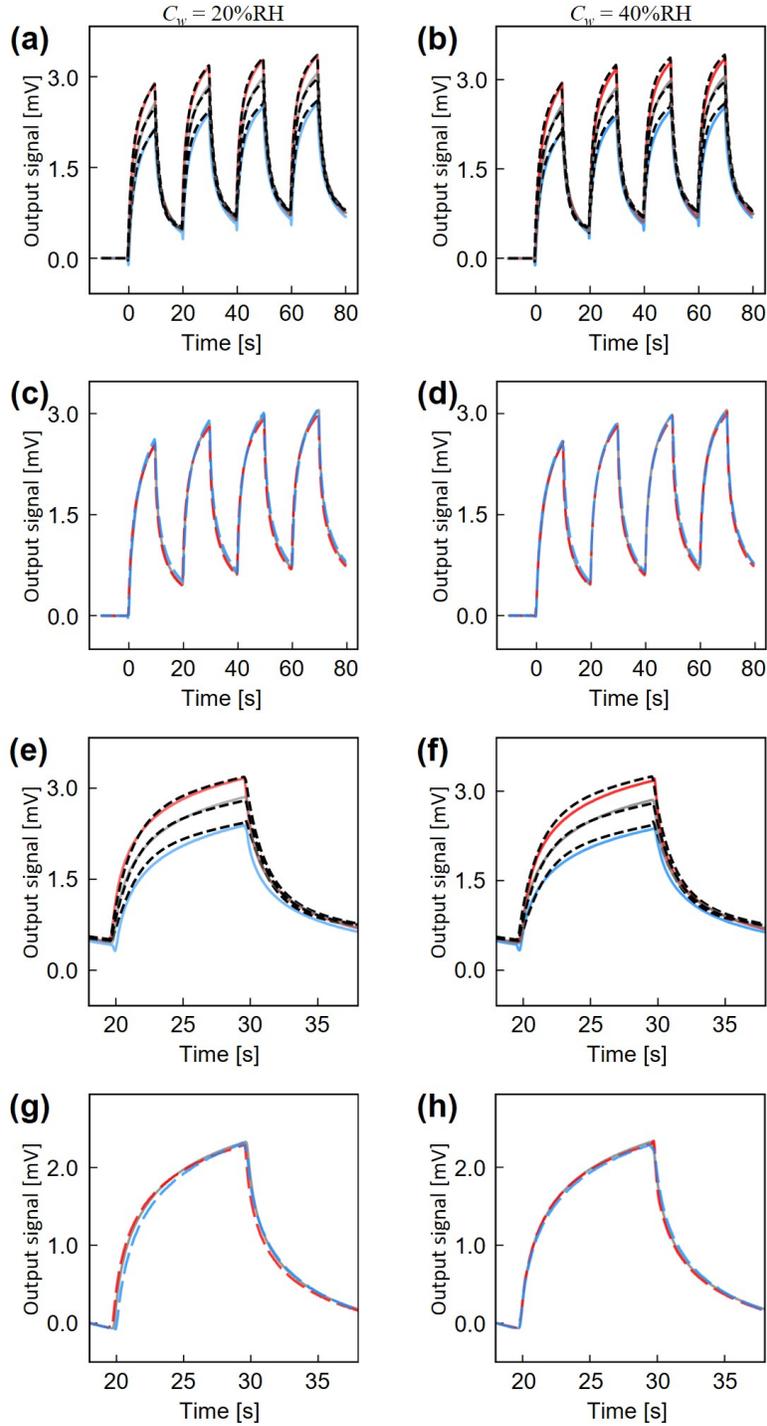


FIG. S9. Responses to toluene under positive and negative humidity changes ($\Delta C_w = \pm 20\%RH$). a,b) The responses to toluene vapor at $C_g = 10\%$ under positive (red; $\Delta C_w = 20\%RH$) and negative humidity changes (blue; $\Delta C_w = -20\%RH$). c,d) Subtracted signals. Gray, pure toluene; red dashed lines, $\Delta C_w = 20\%RH$; blue dashed lines, $\Delta C_w = -20\%RH$. e,f) Magnified responses from 20 to 40 s. g,h) Subtracted signals. See also Fig. S11 for comparison between the pure signal and subtracted responses.

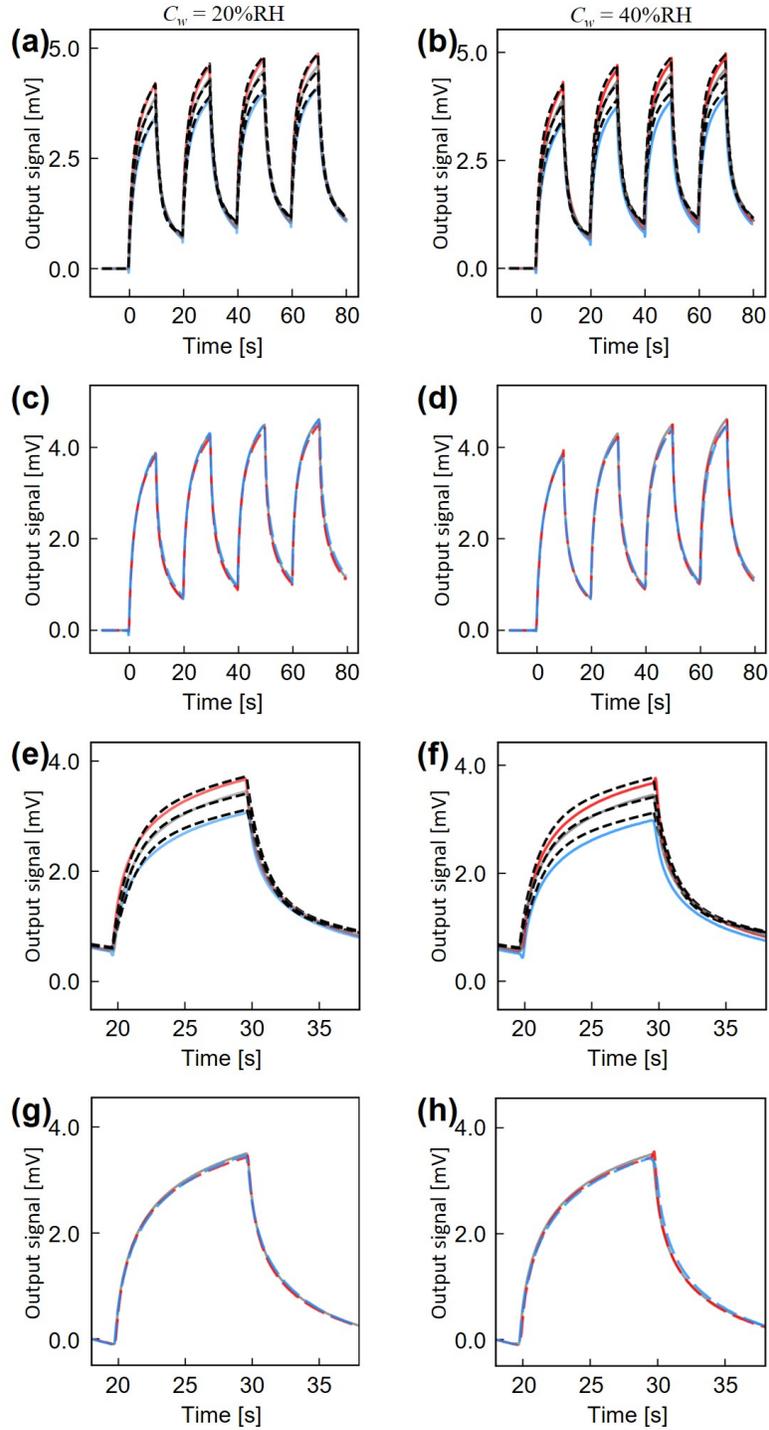


FIG. S10. Responses to toluene under positive and negative humidity changes ($\Delta C_w = \pm 20\%RH$). a,b) The responses to toluene vapor at $C_g = 15\%$ under positive (red; $\Delta C_w = 20\%RH$) and negative humidity changes (blue; $\Delta C_w = -20\%RH$). c,d) Subtracted signals. Gray, pure toluene; red dashed lines, $\Delta C_w = 20\%RH$; blue dashed lines, $\Delta C_w = -20\%RH$. e,f) Magnified responses from 20 to 40 s. g,h) Subtracted signals. See also Fig. S11 for comparison between the pure signal and subtracted responses.

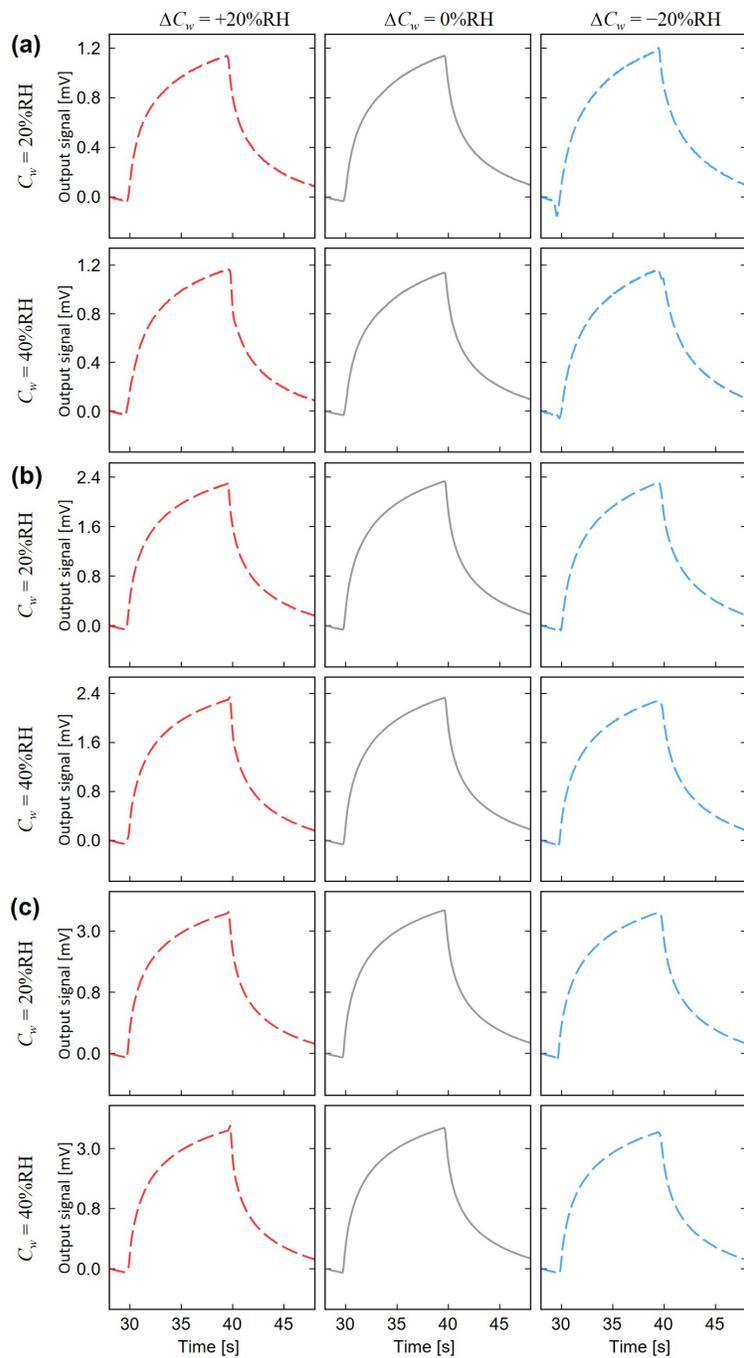


FIG. S11. Comparison of subtracted responses obtained from positive ($\Delta C_w = 20\%RH$; red dashed lines) and negative humidity differences ($\Delta C_w = -20\%RH$; blue dashed lines) to the responses to pure toluene vapors (gray lines). $C_i = 5\%$ (a), 10% (b), and 15% (c).