Supplementary Information for

Colorimetric Visualization Using Polymeric Core–Shell Nanoparticles: Enhanced Sensitivity for Formaldehyde Gas Sensors

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Figure S1. Particle size distribution dependence on PEI ratio in PSMA-PEI core–shell nanoparticles.
Figure S2. $^1$H-NMR spectra (500 MHz) of PEI and PEI/formaldehyde.
Figure S3. Colorimetric response (RGB values and difference map) of (a,b) BCP, (c,d) MR, and (e,d) 4-NP sensors prepared with various PEI ratios (0–10) on exposure to 20 ppm formaldehyde gas.
Figure S4. Colorimetric response (ΔRGB values) of the MR sensor to temperature changes (30–50 °C).
**Figure S5.** Ultraviolet-Visible Spectrophotometer (UV-Vis) of pH dye (4-NP, BCP and MR) and formaldehyde sensors
**Table S1.** Dependence of particle size and shell thickness dependence on PEI content of PSMA-PEI core–shell nanoparticles.

| PEI ratio | Particle size (nm) | Shell thickness(nm) |
|-----------|-------------------|---------------------|
| 0         | 221               | 0                   |
| 0.5       | 248               | 27                  |
| 1         | 253               | 32                  |
| 2         | 254               | 33                  |
| 4         | 260               | 39                  |
| 6         | 261               | 40                  |
| 8         | 251               | 30                  |
| 10        | 248               | 27                  |
Table S2. Colorimetric response of BCP, MR, and 4-NP sensors prepared with various PEI ratios (0–10) on exposure to 20 ppm formaldehyde.

| PEI ratio | Colorimetric response (ΔRGB) |
|-----------|-----------------------------|
|           | BCP       | MR       | 4-NP     |
| 1         | 5679.24   | 5259.62  | 2557.22  |
| 2         | 6571.34   | 6561.02  | 2982.66  |
| 4         | 8570.68   | 8718.36  | 3794.50  |
| 6         | 4605.40   | 5140.98  | 2143.24  |
| 8         | 3568.86   | 4405.06  | 1867.38  |
| 10        | 3170.14   | 3670.12  | 1707.64  |
Table S3. Colorimetric response of BCP, MR, and 4-NP sensors on exposure to 0.5–20 ppm formaldehyde gas. (PEI ratio 4)

| Formaldehyde gas (ppm) | Colorimetric response (ΔRGB) |
|------------------------|-----------------------------|
|                        | BCP | MR     | 4-NP  |
| 0.5                    | 5310.34 | 5916.12 | 1477.64 |
| 0.75                   | 6212.06 | 5881.22 | 1584.68 |
| 1                      | 6831.88 | 5895.24 | 1861.18 |
| 10                     | 8313.18 | 8624.08 | 3254.98 |
| 20                     | 8570.68 | 8718.36 | 3794.50 |
**Table S4.** Colorimetric response of the MR sensor over time (0.5–5 min).

| Time (min) | 0.5  | 0.75 | 1   | 10  | 20  |
|------------|------|------|-----|-----|-----|
| 0.5        | 5037.76 | 5057.16 | 5052.63 | 7330.04 | 7497.48 |
| 1          | 5342.72 | 5410.52 | 5405.84 | 7934.08 | 8020.56 |
| 2          | 5846.45 | 5800.66 | 5793.41 | 8523.41 | 8625.22 |
| 3          | 5856.84 | 5822.15 | 5819.15 | 8537.76 | 8630.82 |
| 4          | 5861.15 | 5824.84 | 5873.54 | 8608.54 | 8713.66 |
| 5          | 5916.12 | 5881.22 | 5875.24 | 8624.08 | 8718.36 |
| Humidity (RH%) | Formaldehyde (ppm) |
|--------------|-------------------|
|              | 0.5   | 0.75  | 1     | 10    | 20    |
| 5            | 3194.64 | 3224.55 | 3231.25 | 4829.44 | 4894.90 |
| 10           | 5333.56 | 5351.71 | 5405.00 | 7847.84 | 8020.56 |
| 30           | 5916.12 | 5981.22 | 5985.24 | 8624.08 | 8718.36 |
| 50           | 3431.28 | 3469.79 | 3548.75 | 5174.40 | 5178.62 |
| 70           | 1124.04 | 1176.20 | 1175.00 | 1552.32 | 1743.6  |
| 90           | 640.76  | 646.90  | 705.00  | 1121.12 | 1133.34 |