Supporting Information

QCM-Based HCl Gas Detection on Dimethylamine-Functionalized Crosslinked Copolymer Films

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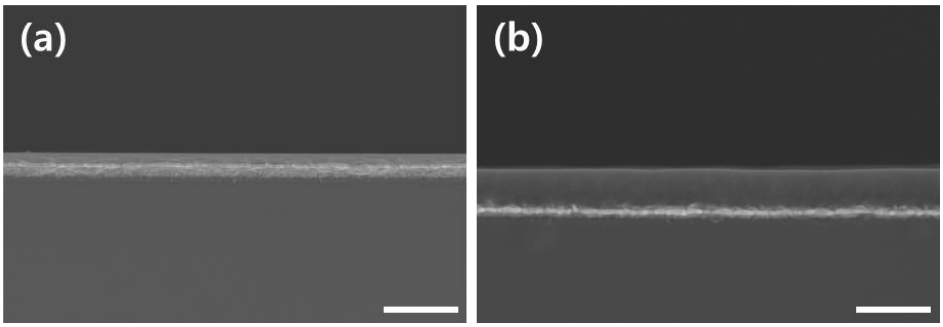

Figure S1. Cross-sectional scanning electron microscopy (SEM) images of poly(DMAEMA-co-EGDMA) films with mass of (**a**) 1.7 μg and (**b**) 11.8 μg, respectively. All scale bars are 1 μm.

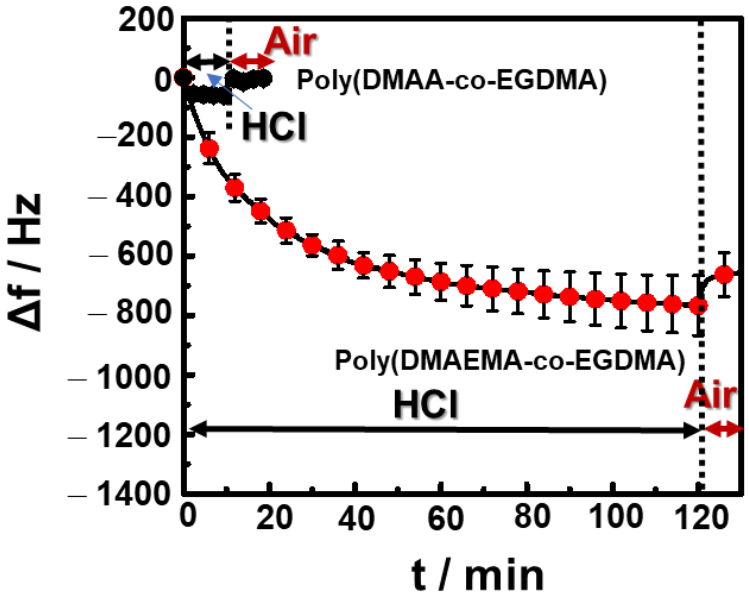

Figure S2. Resonant frequency change (Δ*f*) as a function of time for poly(DMAEMA-co-EGDMA) and poly(DMAA-co-EGDMA) films in 70-ppm HCl and synthetic air flow at 22°C (10% RH). The adsorption–desorption process was performed until the signal stabilized.

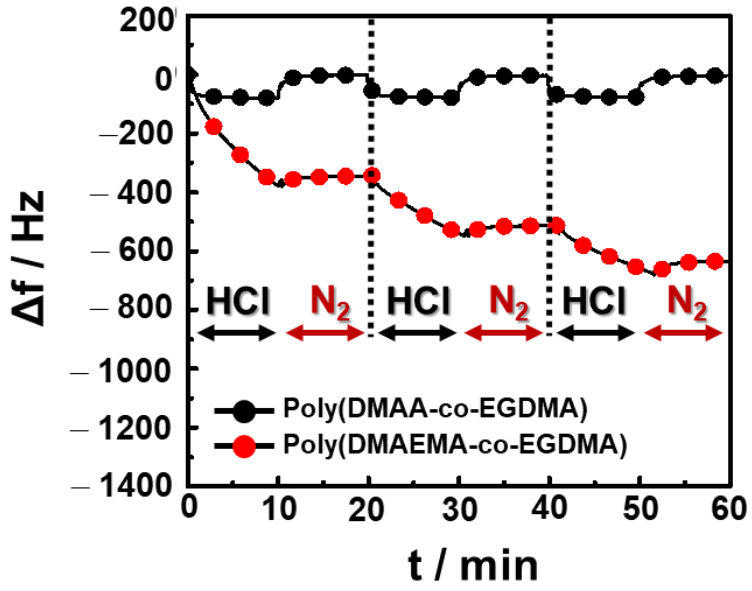

Figure S3. Resonant frequency change (Δ*f*) as a function of time for poly(DMAEMA-co-EGDMA) and poly(DMAA-co-EGDMA) films in 100-ppm HCl and N_2 flow at 22°C (10% RH). Three cycles adsorption–desorption process was performed.

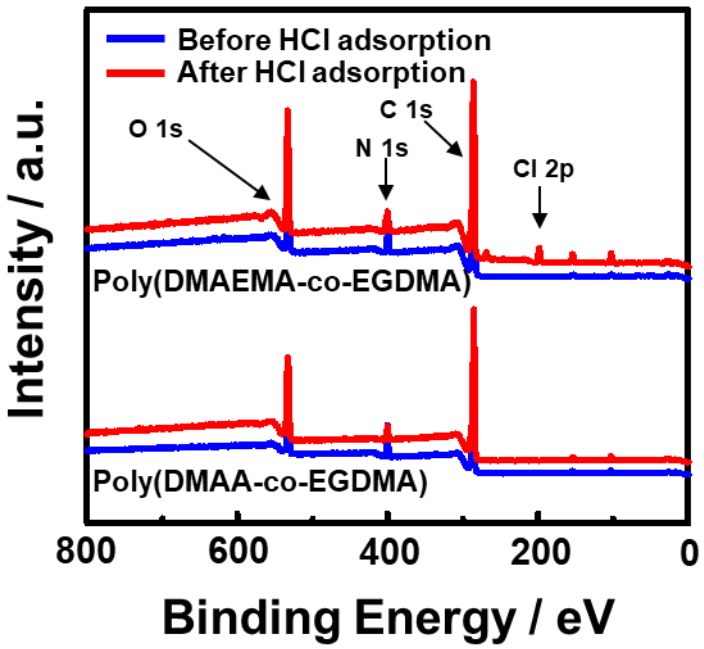

Figure S4. XPS wide scan spectra for poly(DMAEMA-co-EGDMA) and poly(DMAA-co-EGDMA) films before and after HCl adsorption.

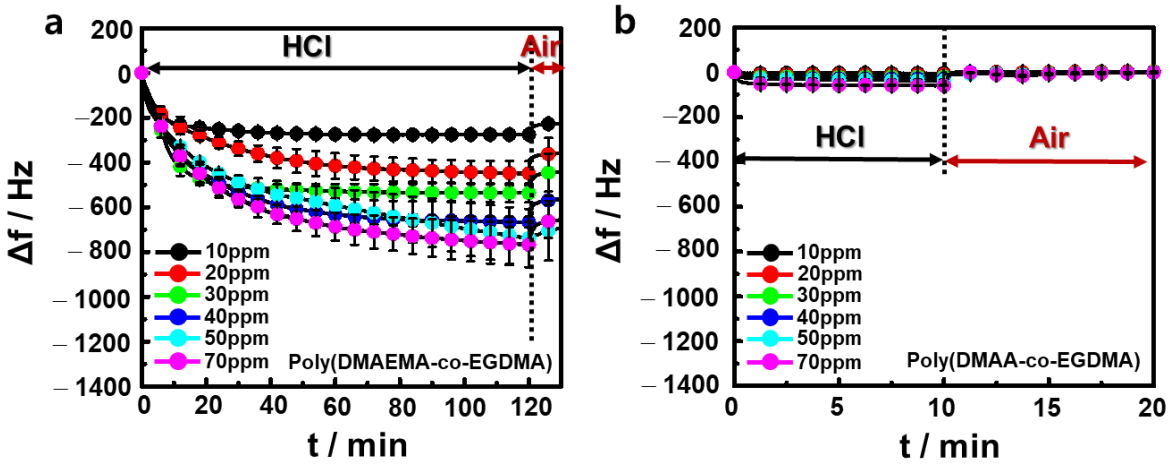

Figure S5. Resonant frequency change (Δf) as a function of time for (**a**) poly(DMAEMA-co-EGDMA) and (**b**) poly(DMAA-co-EGDMA) films in HCl gas flow ranging from 10 to 70 ppm at 22 °C and 10% RH during the adsorption process. Synthetic air was used for desorption, and the desorption process was performed until the signal stabilized.

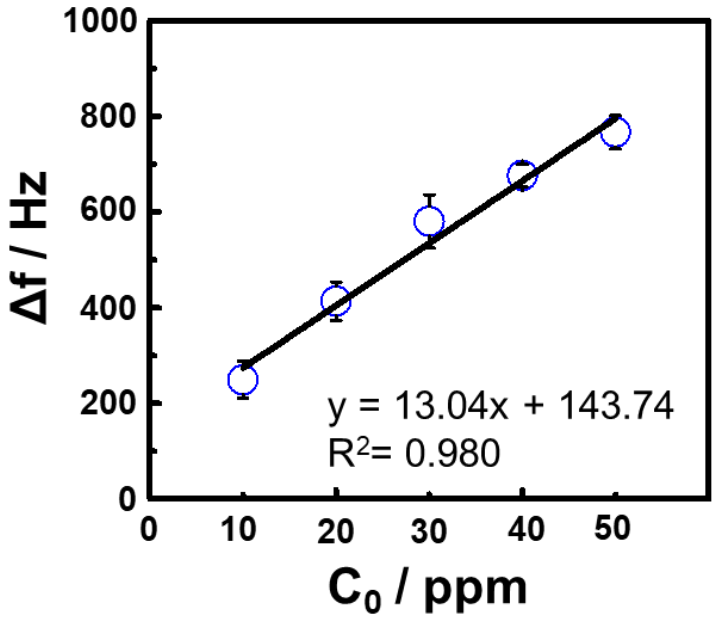

Figure S6. Linear regression curve of poly(DMAEMA-co-EGDMA) for resonant frequency change (Δf) as a function of HCl concentration in HCl ranging from 10 to 50 ppm.

Table S1. Comparison of HCl on various sensor configurations, including the sensitivity and limit of detection in a linear range

Sensor Configuration	Sensitivity	LOD[a]	Reference
PDMAA[b] film	4 Hz/ppm	2.5 ppm	1
PNIPAM[c] nanopaticle	3.8 Hz/ppm	-	2
PNIPAM nanopaticle	3.3 Hz/ppm	-	3
Aminated polystyrene particles	3.88 Hz/ppm	5 ppm	4
Morpholine-functional styrene based copolymer[d]	10 Hz/ppm	-	5
This work	13 Hz/ppm	0.55 ppm	-

[a] Limit of detection. [b] Poly(N,N-dimethylacrylamide) [c] Poly(N-isopropylacrylamide) [d] Morpholine-functional styrene-co-chloromethylstyrene copolymer

Table S2. Fitting parameters of the Langmuir and Freundlich models for the adsorption of HCl gas on two crosslinked films.

Samples	Langmuir			Freundlich		
	k_L[a] (L/mg)	Q_m[b] (mg/g)	R^2	k_F[c] (mg/g)(L/mg)$^{1/n}$	1/n[d]	R^2
C3-DMA	17.1	252.4	0.996	521.5	0.52	0.976
C0-DMA	9.6E-4	89627.8	0.890	85.7	1	0.890

[a] Langmuir adsorption equilibrium constant. [b] maximum adsorption capacity. [c] Freundlich adsorption equilibrium constant. [d] heterogeneity factor; R^2 correlation coefficient.

[1] Matsuguchi, M.; Kadowaki, Y. Poly(acrylamide) derivatives for QCM-based HCl gas sensor applications. *Sens. Actuators B Chem.* **2008**, *130*, 842–847.

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[3] Matsuguchi, M.; Fujii, S. HCl gas sensor coating based on poly (N-isopropylacrylamide) nanoparticles prepared from water-methanol binary solvent. *Sensors* **2018**, *18*, 3283.

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[5] Matsuguchi, M.; Kadowaki, Y.; Noda, K.; Naganawa, R. HCl gas monitoring based on a QCM using mor-pho-line-functional styrene-co-chloromethylstyrene copolymer coatings. *Sens. Actuators B Chem.* **2007**, *120*, 462–466.