# Supplementary

$$D = \frac{K\lambda}{\beta \cos \theta} \tag{1}$$

where $\lambda$ (X-ray wavelength) = 0.15418 nm, $\theta$ = Bragg's angle ($2\theta$ = 25.15), $\beta$ = full width and half maxima. $D$ = Crystallite size, $B$= the line width at half-maximum height after the subtraction of equipment broadening, and $K$ = Scherrer constant (0.089).

$$\frac{q_t}{q_e} = 6(\frac{D_1}{\pi a^2})^{0.5} t^{0.5} + C \tag{3}$$

A ($\mu m$) is the average $HTiO_2@AC/SiO_2$ radius, and $D_1$ is the film diffusion coefficient ($\mu m^2\ S^{-1}$).