Electronic supplementary information

The enzyme-catalysed hydrolysis of urea yields ammonia and carbon dioxide.

$$R1: CO(NH_2)_2 + H_2O \xrightarrow{\text{urease}} 2NH_3 + CO_2$$

The pH is determined by the following equilibria

$$R2: NH_3 + H^+ \underset{k_{2r}}{\overset{k_2}{\rightleftharpoons}} NH_4^+$$

$$R3: CO_2 + H_2O \underset{k3r}{\overset{k3}{\rightleftharpoons}} H^+ + HCO_3^-$$

$$R4: HCO_3^- \underset{k_{4r}}{\overset{k_4}{\rightleftharpoons}} CO_3^{2-} + H^+$$

$$R5: H^+ + OH^- \underset{k_{5r}}{\overset{k_5}{\rightleftharpoons}} H_2O$$

$$A_2 = k_2[NH_3][H^+] - k_{2r}[NH_4^+] \quad \text{(S1)}$$

$$A_3 = k_3[HCO_3^-][H^+] - k_{3r}[CO_2] \quad \text{(S2)}$$

$$A_4 = k_{4r}[HCO_3^-] - k_4[CO_3^{2-}][H^+] \quad \text{(S3)}$$

$$A_5 = k_{5r} - k_5[H^+][OH^-] \quad \text{(S4)}$$

The rate equations corresponding to the full mechanism given by R1-R5 are the following:

$$\frac{d[CO(NH_2)_2]}{dt} = -R \quad \text{(S5)}$$

$$\frac{d[NH_3]}{dt} = 2R - A_2 \quad \text{(S6)}$$

$$\frac{d[NH_4^+]}{dt} = A_2 \quad \text{(S7)}$$

$$\frac{d[CO_2]}{dt} = R + A_3 \quad \text{(S8)}$$

$$\frac{d[HCO_3^-]}{dt} = -A_3 - A_4 \quad \text{(S9)}$$

$$\frac{d[CO_3^{2-}]}{dt} = A_4 \quad \text{(S10)}$$

$$\frac{d[H^+]}{dt} = A_5 + A_4 - A_3 - A_2 \quad \text{(S11)}$$

$$\frac{d[OH^-]}{dt} = A_5 \quad \text{(S12)}$$

With R is defined with equation described in the main text.

Table S1 Other parameters used in the simulation of immobilization effect

Parameters	value	Parameters	value
k_2 / M^{-1} s^{-1}	4.3×10^{10}	K_E /mL $U^{-1}M^{-1}$ s^{-1}	3.7×10^{-6}
k_{2r} / s^{-1}	24	K_m/M	3×10^{-3}
k_3 / s^{-1}	3.7×10^{-2}	K_S/M	3
k_{3r} / M^{-1} s^{-1}	7.9×10^4	k_5 / M^{-1} s^{-1}	10^{11}
k_4 / s^{-1}	2.8	k_{5r} / s^{-1}	10^{-3}
k_{4r} / M^{-1} s^{-1},	5×10^{10}		