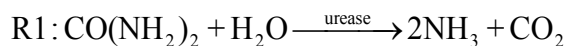


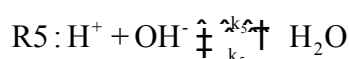
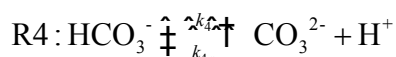
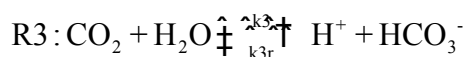
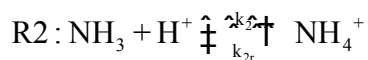
$$\frac{d[\text{OH}^-]}{dt} = A_5 \quad (\text{S12})$$

Electronic supplementary information

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



The pH is determined by the following equilibria



$$A_2 = k_2[\text{NH}_3][\text{H}^+] - k_{2r}[\text{NH}_4^+] \quad (\text{S1})$$

$$A_3 = k_3[\text{HCO}_3^-][\text{H}^+] - k_{3r}[\text{CO}_2] \quad (\text{S2})$$

$$A_4 = k_{4r}[\text{HCO}_3^-] - k_4[\text{CO}_3^{2-}][\text{H}^+] \quad (\text{S3})$$

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

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

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

$$\frac{d[\text{NH}_3]}{dt} = 2R - A_2 \quad (\text{S6})$$

$$\frac{d[\text{NH}_4^+]}{dt} = A_2 \quad (\text{S7})$$

$$\frac{d[\text{CO}_2]}{dt} = R + A_3 \quad (\text{S8})$$

$$\frac{d[\text{HCO}_3^-]}{dt} = -A_3 - A_4 \quad (\text{S9})$$

$$\frac{d[\text{CO}_3^{2-}]}{dt} = A_4 \quad (\text{S10})$$

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

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
$k_2 / \text{M}^{-1} \text{s}^{-1}$	4.3×10^{10}	$K_E / \text{mL U}^{-1} \text{M}^{-1} \text{s}^{-1}$	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
$k_{3r} / \text{M}^{-1} \text{s}^{-1}$	7.9×10^4	$k_5 / \text{M}^{-1} \text{s}^{-1}$	10^{11}
k_4 / s^{-1}	2.8	k_{5r} / s^{-1}	10^{-3}
$k_{4r} / \text{M}^{-1} \text{s}^{-1}$	5×10^{10}		