Supplementary Information

The deduction of formula (3) is as follows:
According to ideal gas equation

$$P_g M = \rho RT \qquad (1$$

and considering the gas pressure and the composition proportion in the bubble changed with the CO_2 diffusion, resulting in the change of the mixed gas density.

$$\frac{d\rho}{dt} = \frac{M}{RT}\frac{dP_g}{dt} + \frac{P_g}{RT}\frac{dM}{dt} \qquad (2$$

where P_g is the pressure in the bubble, according to Young-Laplace equation, written as

$$P_g = P_l + \frac{2\sigma}{R_b} \qquad (3$$

M is the molecular weight of mixed gas, given by

$$M = x_{CO_2} M_{CO_2} + x_{\mathrm{Air}} M_{\mathrm{Air}} \qquad (4$$

Combining Equations (2, (3 and (4 yields the resulting expression,

$$\frac{d\rho}{dt} = -\frac{2\sigma M}{RTR_b^{\,2}}\frac{dR_b}{dt} + \frac{P_g}{RT}\left(M_{CO_2}\frac{dx_{CO_2}}{dt} + M_{Air}\frac{dx_{Air}}{dt}\right)$$

$$= -\frac{2\sigma M}{RTR_b^{\,2}}\frac{dR_b}{dt} + \frac{P_g}{RT}\left(M_{CO_2} - M_{Air}\right)\frac{dx_{CO_2}}{dt}$$

$$= -\frac{2\sigma M}{RTR_b^{\,2}}\frac{dR_b}{dt} + x_{Air}\left(M_{CO_2} - M_{Air}\right)\left(\frac{4\pi R_b^{\,2} P_l}{RT} + \frac{16\pi\sigma R_b}{3RT}\right)\frac{dR_b}{dt}$$

$$= \left[-\frac{2\sigma M}{RTR_b^{\,2}} + \left(M_{CO_2} - M\right)\left(\frac{3P_l}{RTR_b} + \frac{4\sigma}{RTR_b^{\,2}}\right)\right]\frac{dR_b}{dt} \qquad (5$$

The change rate of gas mass in the bubble can be calculated as:

$$\frac{dm}{dt} = \frac{d\left(\frac{4}{3}\pi R_b^{\,3}\rho\right)}{dt} = 4\pi R_b^{\,2}\rho\frac{dR_b}{dt} + \frac{4}{3}\pi R_b^{\,3}\frac{d\rho}{dt}$$

$$= 4\pi R_b^{\,2}\rho\frac{dR_b}{dt} + \frac{4}{3}\pi R_b^{\,3}\left[-\frac{2\sigma M}{RTR_b^{\,2}} + \left(M_{CO_2} - M\right)\left(\frac{3P_l}{RTR_b} + \frac{4\sigma}{RTR_b^{\,2}}\right)\right]\frac{dR_b}{dt}$$

$$= \left[4\pi R_b^{\,2}\rho - \frac{8\pi\sigma M R_b}{3RT} + \left(M_{CO_2} - M\right)\left(\frac{4\pi R_b^{\,2} P_l}{RT} + \frac{16\pi\sigma R_b}{3RT}\right)\right]\frac{dR_b}{dt}$$

$$=\left\{\rho-\left[\frac{2\sigma}{R_b}-\left(\frac{M_{CO_2}}{M}-1\right)P_l+\frac{M_{CO_2}}{M}\cdot\frac{4\sigma}{3R_b}\right]\frac{M}{RT}\right\}4\pi R_b{}^2\frac{dR_b}{dt} \quad (6$$

Considering the change rate of gas mass in the bubble is equal to the CO_2 diffusion rate through the gas-liquid interface

$$\frac{dm}{dt}=-4\pi R_b{}^2 j_{R_b} \quad (7$$

where j_{R_b} is the CO_2 diffusion flux through the gas-liquid interface, which can be obtained by applying Fick's first law in the microalgae suspension as

$$j_{R_b}=-M_{CO_2}D_{CO_2}\frac{\partial C}{\partial r}\Big|_{r=R_b} \quad (8$$

Combining formula (6, (7 and (8, the decreasing rate of the bubble radius can be obtained by

$$\frac{dR_b}{dt}=\left\{\rho-\left[\frac{2\sigma}{R_b}-\left(\frac{M_{CO_2}}{M}-1\right)P_l+\frac{M_{CO_2}}{M}\cdot\frac{4\sigma}{3R_b}\right]\frac{M}{RT}\right\}^{-1}M_{CO_2}D_{CO_2}\frac{\partial C}{\partial r}\Big|_{r=R_b} \quad (9$$