

$$\frac{dc_k}{dt} = D_k^{\text{eff}} \left[ \frac{d^2 c_k}{dr_k^2} + \frac{2}{r_k} \frac{dc_k}{dr_k} + \theta_{M,k} \left( \frac{dc_k}{dr_k} \right)^2 + \theta_{M,k} \bar{c}_k \left( \frac{d^2 c_k}{dr_k^2} + \frac{2}{r_k} \frac{dc_k}{dr_k} \right) \right], \quad \text{cartesian coordinate} \quad (5)$$

$$\left. \frac{\partial c_k}{\partial r_k} \right|_{r_k=0} = 0, \quad (1 + \theta_{M,k} \bar{c}_k) D_k^{\text{eff}} \left. \frac{\partial c_k}{\partial r_k} \right|_{r_k=R_k} = -\frac{j_k^{\text{Li}}}{a_k F}, \quad k = si, g \quad (6)$$