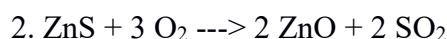


CERAMIC AND COLLOIDAL PROCESSING - EXERCISES

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Exercises 3

1. What mineral powders (and their percentages) are used for the production of hard porcelain,
2. What is the simple model describing the decomposition of a salt or the oxidation of a metal for the synthesis of a ceramic powder? What are the steps that can limit the kinetics of fluid-solid reactions?
3. Zinc blende particles having a radius $R = 1 \text{ mm}$ are calcined in a gas flow of 8% oxygen at 900°C and 1 atmosphere. The stoichiometry of the reaction is:



Assuming the reaction progresses according to the shrinking core model

- (a) Calculate the time required for complete conversion of a particle and the relative resistance due to diffusion through the product layer during this operation.
- (b) Do the same calculation for particles with radius $R = 0.05 \text{ mm}$.

Problem data:

Density of solid $\rho_B = 4.13 \text{ g / cm}^3 = 0.0425 \text{ Mol / cm}^3$

Reaction rate constant $k_s = 2 \text{ cm / sec}$.

Ideal gas constant $R_g = 82.057 \text{ atm.cm}^3 / \text{K} \cdot \text{Mol}$

For gases in the ZnO layer, $D_p = 0.08 \text{ cm}^2 / \text{sec}$, $b = 2/3$

Note that the resistance of the laminar gas layer can be safely neglected as long as the growth of the product layer is taking place, also considering only the effects of mass transfer and $C_a = P_{\text{O}_2} / R_g T \text{ (Mol / cm}^3 \text{)}$.

What are the consequences of the size reduction on the reaction kinetics?

4. Give a typical solid-solid reaction to produce a ceramic powder.
5. When diffusion controls the production rate of the product by the solid-solid route, how does the thickness of the product layer increase as a function of time?
How can we speed up the reaction?
6. How does the decomposition temperatures of CaCO_3 , BaCO_3 and MgCO_3 vary as a function of the partial pressure of CO_2 in the gas of a furnace i) standard state (1 atm of CO_2) ii) ambient air ($p_{\text{CO}_2} 5 \times 10^{-4} \text{ atm}$) iii) nitrogen with 10ppm CO_2 (10^{-5} atm)