

# KINETIC ANALYSIS OF THE THERMALLY INDUCED TRANSFORMATIONS OF CALCIUM HYDROXIDE IN DIFFERENT GASEOUS ATMOSPHERES

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The atmospheric gas that contributes to the thermally induced reaction in the solid–gas system as the product or reactant is one of the most relevant factors to control the kinetics and mechanisms of the reaction. Because of the heterogeneous feature of the reactions in the solid–gas system, change in the atmospheric conditions imposes the dramatical change in the physico-geometrical reaction mechanism and overall kinetics in a complex manner of the interactions of the component physico-chemical reaction steps.

Thermally induced transformations of  $\text{Ca}(\text{OH})_2$  are such examples. The thermal decomposition of  $\text{Ca}(\text{OH})_2$  in flowing dry  $\text{N}_2$  gas proceeds via partially overlapping two reaction steps attributed to surface and interfacial reactions [1]. The kinetic feature is described by the cumulative kinetic equation [2].

$$\frac{d\alpha}{dt} = \sum_{i=1}^N c_i A_i \exp\left(-\frac{E_{a,i}}{RT}\right) f_i(\alpha_i) \quad (1)$$

where  $c_i$  is the contribution of the reaction step  $i$ .

On heating  $\text{Ca}(\text{OH})_2$  in flowing  $\text{N}_2\text{--CO}_2$  mixed gas, mass-change curve exhibits a smooth mass gain, which is invariant irrespective of  $\text{CO}_2$  concentration (Figure 1(a)). The reaction is interpreted as the consecutive process of the thermal decomposition of  $\text{Ca}(\text{OH})_2$  and subsequent carbonation of  $\text{CaO}$  to form  $\text{CaCO}_3$ . The overlapping mass-loss and mass-gain processes that do not appear on the experimentally resolved mass-change curve can be simulated by the kinetic deconvolution analysis based on eq. (1) [1].

The thermal decomposition of  $\text{Ca}(\text{OH})_2$  is a typical reversible process in solid–gas system. Therefore, the water vapor pressure  $p(\text{H}_2\text{O})$  in reaction atmosphere restrains the reaction rate, indicating systematic shift of the mass-loss curve recorded under nonisothermal conditions at a selected heating rate to higher temperatures with increasing  $p(\text{H}_2\text{O})$  (Figure 1(b)). The kinetics of the reaction over different  $p(\text{H}_2\text{O})$  is universally described by introducing an appropriate accommodation function in the fundamental kinetic equation.

$$\frac{d\alpha}{dt} = A \exp\left(-\frac{E_a}{RT}\right) f(\alpha) a(p(\text{H}_2\text{O}), P_{\text{eq}}(T)) \quad (2)$$

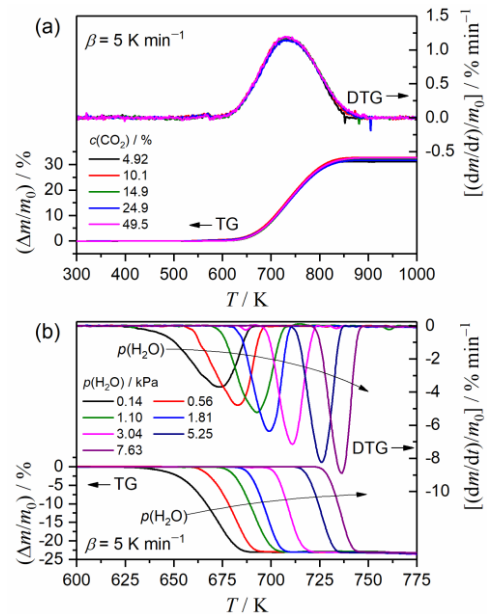
The practical kinetic analyses for those complex reaction processes are demonstrated in this presentation.

## Acknowledgments

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## References

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**Figure 1.** TG–DTG curves for  $\text{Ca}(\text{OH})_2$  recorded under different atmospheric conditions in flowing (a)  $\text{N}_2\text{--CO}_2$  and (b)  $\text{N}_2\text{--H}_2\text{O}$  mixed gases.