Application Brief

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Thermal Analysis of Gypsum

1. Introduction

Gypsum has long been used as a building material and is used for that purpose in the following items.

- Setting retarder for Portland cement
- For gypsum plaster, gypsum board, ceramic molding tools, and arts and crafts
- Auxiliary material for nickel smelting and a source of sulfur
- Filler for rubber, paper, and so on.
- A tofu coagulant
- A special component for optical devices
- Pharmaceuticals, plaster casts, dental prosthesis, fever medicine and cough suppressants and other medicinal uses.

It is important to know the characteristics of gypsum before using it. The thermal characteristics of gypsum produce the following thermal changes.

$$\underset{\text{dihydrate gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{60\sim150^\circ C} \underset{\text{hemihydrate gypsum}}{CaSO_4 \cdot 1/2H_2O} \xrightarrow{105\sim240^\circ C} \underset{\text{anhydrous gypsum}}{CaSO_4}$$

$$CaSO_4 \cdot 2H_2O \leftrightarrow CaSO_4 \cdot 1/2H_2O + 3/2H_2O$$
$$\leftrightarrow CaSO_4 + 2H_2O \quad \cdots\cdots\cdots (1)$$

These are equilibrium reactions. The hardening of baked plaster kneaded in water indicates the transition from hemihydrate gypsum to crystalline gypsum (dihydrate gypsum).

This brief presents examples of TG/DTA and DSC measurements of the thermal changes of gypsum.

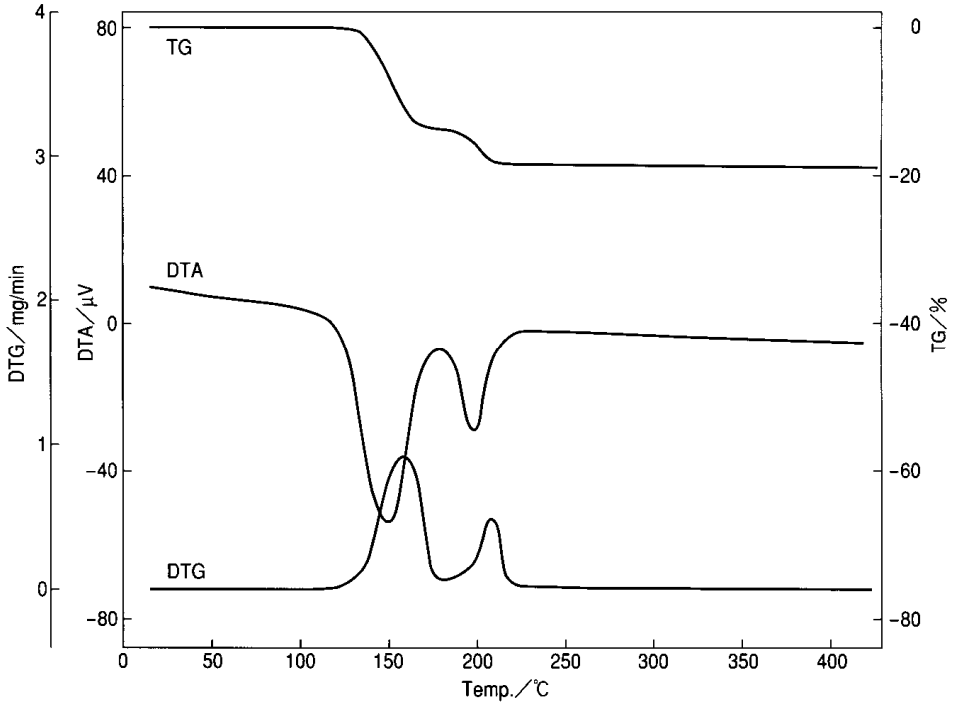

Figure 1　TG/DTA results for dihydrate gypsum

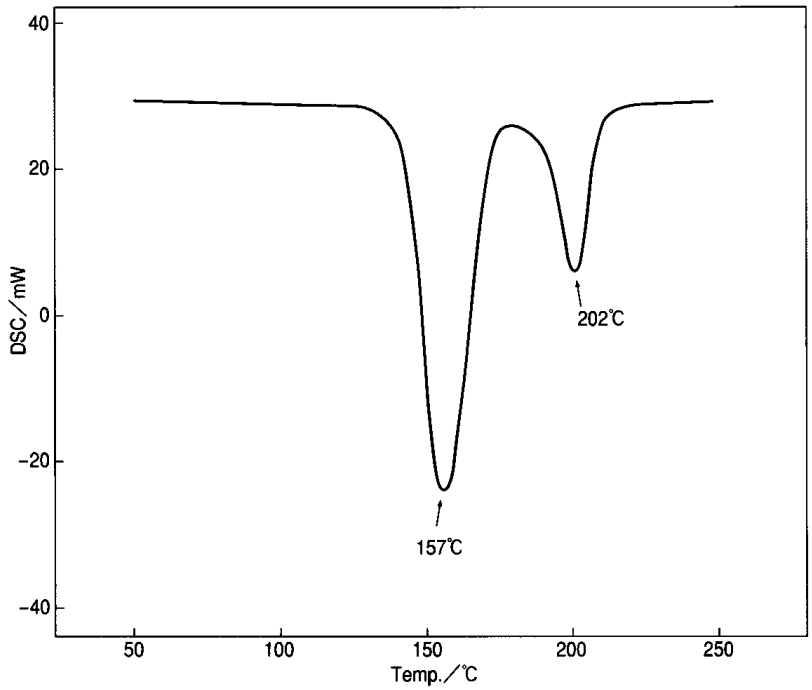

Figure 2　DSC results for dihydrate gypsum

2. Results

Figure 1 shows the TG/DTA results for dihydrate gypsum. A 30mg sample was placed in a semi-hermetically sealed container, which was a hermetically sealed aluminum container with a pinhole in the lid. The atmosphere was 200ml/min of air and the heating rate was 5°C/min. In this semi-hermetic state, the TG curve showed a 2-stage weight decrease corresponding to the evaporation of water. The decreases correlate well with the theoretical values below.

		$-3/2H_2O$		$-1/2H_2O$	
	$CaSO_4 \cdot 2H_2O$	→	$CaSO_4 \cdot 1/2H_2O$	→	$CaSO_4$
Formula weight:	172.17		145.15		136.14

Figure 2 shows the DSC measurement results for the same dihydrate gypsum. For these measurements, a 30mg sample in a semi-hermetically sealed container was heated at a rate of 5°C/min. As with the results in Figure 1, measurements in a semi-hermetic state result in two evaporations of water corresponding to the 2-stage reaction in Formula 1. An integration of these measurement results is shown in Figure 3. The DSC curve reached maximum around 180°C. The thermal ratio of the two peaks was 3 to 1 (75% to 25%), which corresponds well with the ratio of evaporated water molecules.

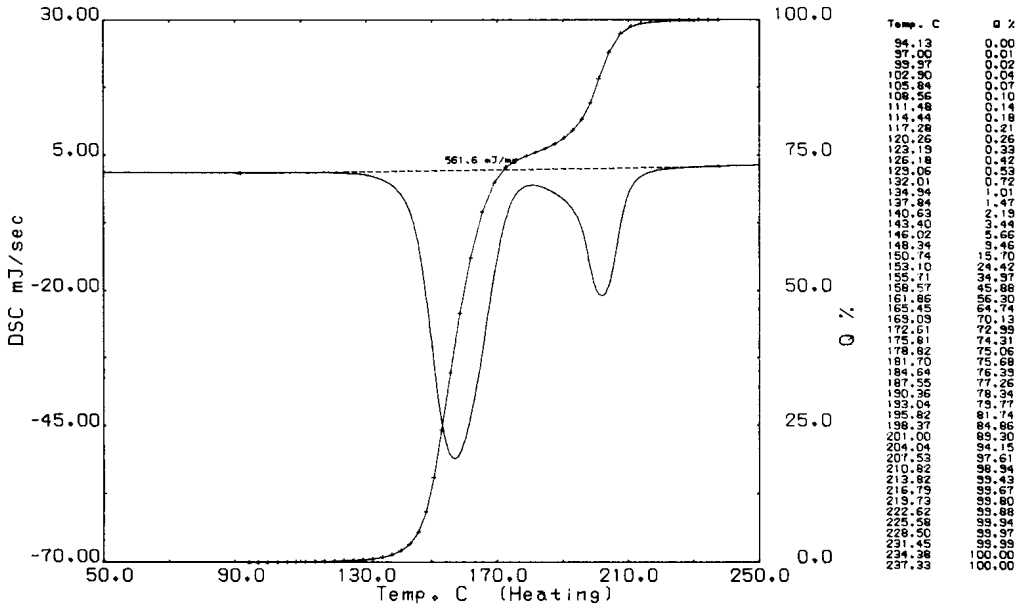

Figure 3 Integration results for dihydrate gypsum