α-Monohydrate Phase in Lactose by DSC

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ABSTRACT

The α-anomer of lactose is hydroscopic with an equilibrium moisture content of 5.0 % monohydrate. The β-anomer is anhydrous. The dehydration of α-lactose takes place near 145 °C with 150 J/g of energy. This dehydration energy, measured by differential scanning calorimetry, is used to quantify the amount of α-anomer in α- and β- lactose mixtures.

INTRODUCTION

Lactose is commonly used as a filler in pharmaceutical capsule and tablet formulations and as a carrier in dry powder inhalation devices. It also has many applications as an ingredient in dairy source food products. The α-monohydrate is typically used in wet granulation formulations while the β-anhydrous phase is used as a direct compression ingredient.

The most commonly encountered form of lactose is its α-anomer, which is obtained in the form of a monohydrate phase (*1*). The anhydrous form of the α-anomer is known to be very hygroscopic and difficult to either obtain or handle. The β-anomer of lactose is obtained as an anhydrate phase that apparently has no tendency to form any hydrate phases. The theoretical water content for the α-monohydrate phase is 5.0 % by weight. The thermal properties of these materials are discussed by Brittain and co-workers (*2*).

EXPERIMENTAL

Examples of α-lactose monohydrate (Foremost 310 grade) and anhydrous β-lactose (Quest DT grade) are used as received. The thermal profiles of these materials is measured by DSC using 2-4 mg of sample in crimped aluminum pans and a heating rate of 10 °C/min.

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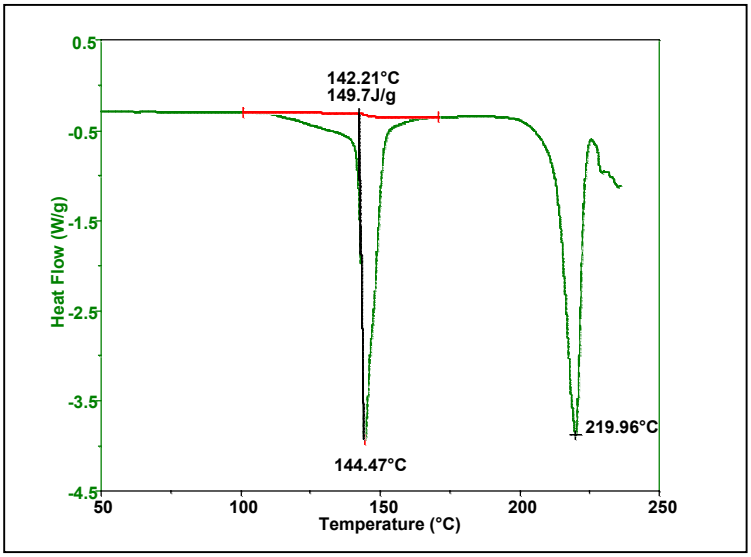

Figure 1 – Thermal Curve for α-Lactose Monohydrate

RESULTS AND DISCUSSION

The resultant DSC thermal curve for α-lactose monohydrate and is shown in Figures 1. The thermal curve is characterized by a strong dehydration endotherm with an onset temperature of 142.2 °C, a peak maximum temperature of 144.5°C, and an enthalpy of dehydration equal to 149.7 J/g. This is followed by the lactose decomposition endotherm near 220 °C.

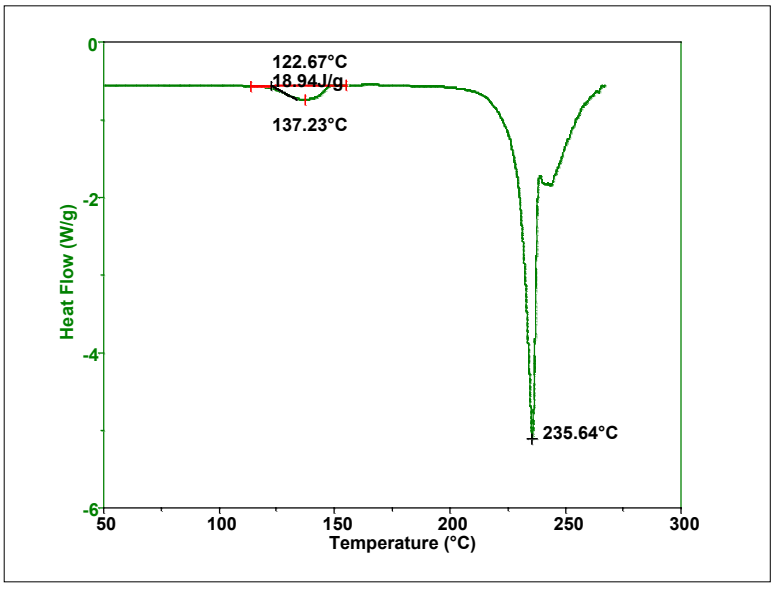

Figure 2 – Thermal Curve for β- Lactose

The DSC profile for β-lactose is shown in Figure 2. Theoretically, the thermal curve should only consist of the decomposition endotherm near 236°C, but the sample

appears to contain a small contamination of the α-monohydrate phase as there is a residual endothermic peak near 128 °C. Based upon the measured dehydration enthalpy of 18.9 J/g, the β-lactose contains some α-monohydrate phase level of 12.6%.

Five samples each at approximately the 90 and 10 % levels were prepared using anhydrous β-lactose as a diluent for the bulk α- lactose monohydrate and the DSC thermal curves obtained. The "known" level of α-lactose in these mixtures was corrected for the impurity level of the α-anomer in the β-lactose. The "observed" level of α-lactose monohydrate determined is compared to the level in the prepared mixtures is shown in Table 1 and is plotted in Figure 3. A least-squares best fit to the data shows a slope correlation of 1.0052 with a near zero offset of -0.023 and an r^2value of 0.9999, representing an excellent correlation acceptable for quantitative analysis.

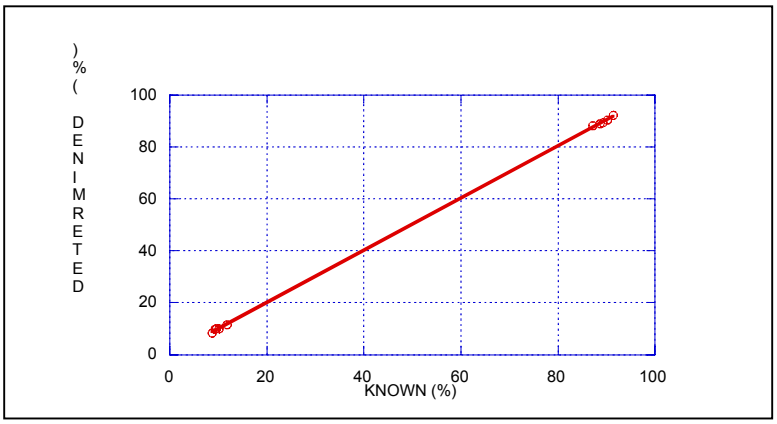

Figure 3 – Comparative Results

CONCLUSION

Provided that the two forms of lactose do not interconvert during acquisition of the DSC thermal curve, and values for the transition enthalpies have been determined for reference materials, DSC may be used to quantify the amount of α-lactose monohydrate in mixtures and blends with the anhydrous β-lactose.

REFERENCES

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2. H. G. Brittain, S. J. Bogdanowich, D. E. Bugay, J. DeVincentis, G. Lewen, and A.W. Newman, *Pharm. Res.*, **1991**, 8, pp. 963-973.

KEYWORDS

decomposition, differential scanning calorimeter, food and food products, pharmaceuticals