Application Brief

Hitachi High-Tech HITACHI

Hitachi High-Tech Science Corporation
RBM Tsukiji Bldg., 15-5, Shintomi 2-chome, Chuo-ku, Tokyo 104-0041
TEL:+81-3-6280-0068 FAX:+81-3-6280-0075
http://www.hitachi-hitec-science.com

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TG/DTA Measurements of Manganese Dioxide

1. Introduction

The use of manganese dioxide as a battery electrolyte is widespread. In most of the batteries, the negative electrode is formed from alkaline metals. This means that if the manganese dioxide electrolyte contains even a trace amount of moisture, the battery will either self-discharge or generate a build-up of gases. Both of these conditions will lead to deterioration of the battery. These factors indicate the importance of a quantitative analysis method for trace moisture determination in manganese dioxide in order to obtain stable performance from a battery.

This application brief describes the use of simultaneous TG/DTA to measure the moisture content in manganese dioxide. TG measurement at partial vacuum can accurately determine quantitative moisture levels in manganese dioxide and aid in determining the required heating and drying conditions for this chemical.

2. Methods and Data

Figure 1 shows the results obtained from simultaneous TG/DTA on manganese dioxide at atmospheric pressure. The TG curve indicates that a reduction in weight due to evaporation of

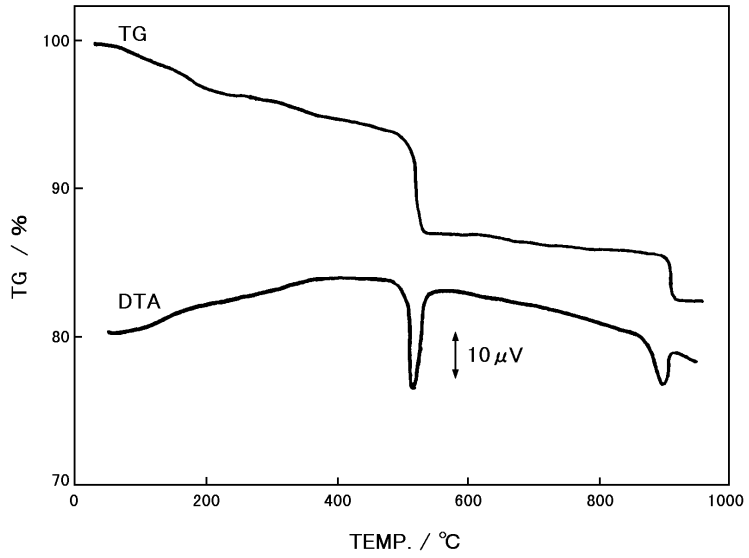

Figure 1 TG/DTA curve of manganese dioxide at Atmospheric pressure
Sample weight : 40mg
Heating rate : 5℃/min
Atmosphere : Air, 100ml/min

contained water begins simultaneously with the start of the temperature increase and weight reduction continues until the sample is heated to over 700℃. Inspection of this curve also shows major losses in weight at around 520℃ and 926℃. These abrupt reductions in sample weight indicate oxygen emitted by the sample reactions expressed in the following reactions:

$$2MnO_2 \rightarrow MnO_2 + 1/2O_2$$

$$3MnO_2 \rightarrow 2Mn_3O_4 + 1/2O_2$$

This decomposition reaction shows that manganese dioxide cannot be heat dried at atmospheric pressure.

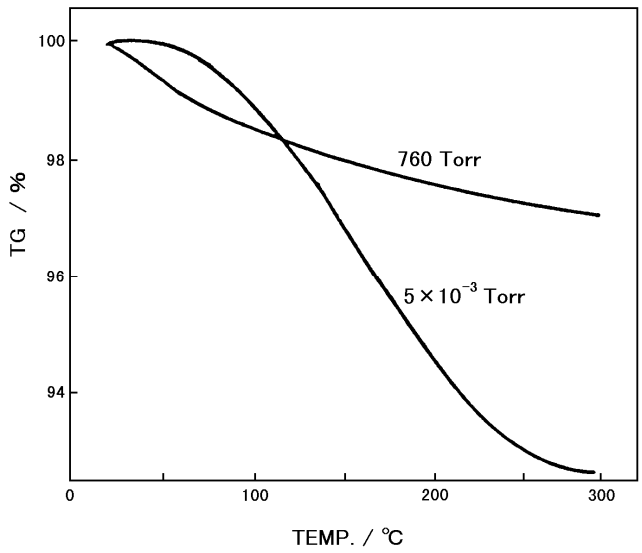

Figure 2 Comparison TG curve for manganese dioxide at Atmospheric pressure and partial vacuum
Sample weight : 40mg
Heating rate : 5℃/min

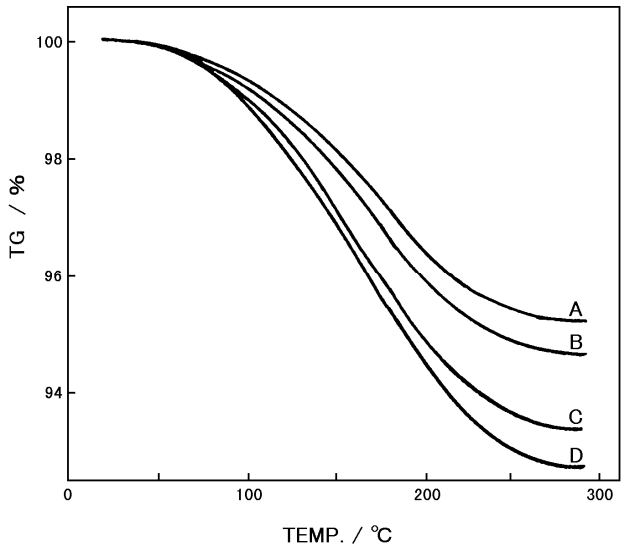

Figure 3 TG curves of four manganese dioxide products generated in a partial vacuum
Sample weight : 40mg
Heating rate : 5℃/min

Another measurement was carried out at partial vacuum conditions of 5×10^{-3} Torr.

The TG curve obtained in Figure 2 shows that a major part of the moisture contained in the manganese dioxide evaporates before the sample temperature reaches 300℃.

While vacuum TG commonly tends to exhibit noise and drift due to the effects of thermal molecular flow, this TG/DTA modules (with their specially designed horizontal differential balance system), minimize this effect. TG results obtained in a vacuum can be as stable as normal atmospheric pressure results.

Figure 3 shows vacuum TG measurement results for four commercially available manganese dioxide products. Each of these samples show a different moisture content.

3. Conclusions

These results show that manganese dioxide can be totally dehydrated when heated to 300℃ in a vacuum.