Application News

SHIMADZU

THERMAL ANALYSIS T95

Measurement of Oxidizing Induction Time of PE by DSC

Polyethylene is a material used to sheath and insulate electric wire. However, over time, polyethylene gradually deteriorates due to the absorption of atmospheric oxygen. To prevent such oxidization, an antioxidant is added to the polyethylene. The effect of the antioxidant may be measured by using DSC to observe the oxidizing induction time.
A sample is heated in an inert gas like nitrogen, until it reaches the desired measuring temperature, and is held there. As this heating time is 'dead time', it is best kept as short as possible.
DSC, the standalone model, enables very rapid heating at approx. 100˚C/min. A retention temperature near 180˚C may also be stable within +/- 0.3˚C of the ideal temperature, showing its practicality.
When the atmosphere is switched from nitrogen to oxygen after the sample reaches the desired measuring temperature, an exothermic peak showing the absorption of oxygen will appear. The time before the peak rises is the induction time, and must be calculated with the origin-point as the point where the atmosphere is switched from nitrogen to oxygen. DSC also functions in this manner; thus, analyses may be quite rapid.

Induction time at 180-210˚C

The polyethylene was cut into fine pieces, and the sample amount was set to 5 mg for measurement. Figure 1 shows data with a retention temperature of 210˚C. An endothermic peak showing melting appeared simultaneous to the start of heating. When the gas was switched to oxygen after reaching a constant temperature, absorption of oxygen started in 7.8 minutes. In the cases of retention temperatures of 200˚C, 190˚C and 180˚C, it was 21.0 minutes (Figure 2), 80.8 minutes (Figure 3) and 281.2 minutes (Figure 4), respectively.

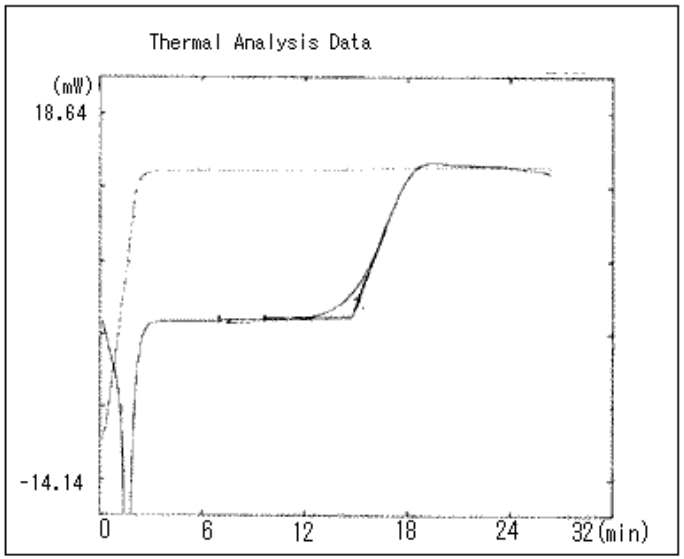

Fig.1 Oxidization of PE at 210°C

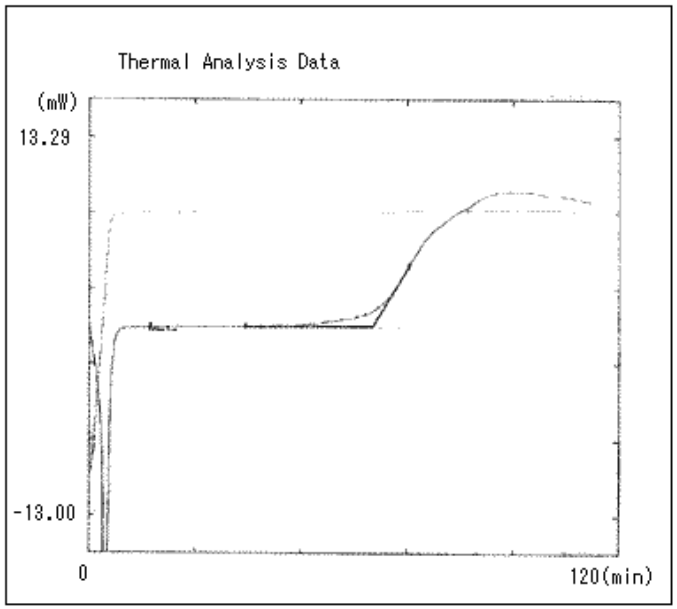

Fig.2 Oxidization of PE at 200°C

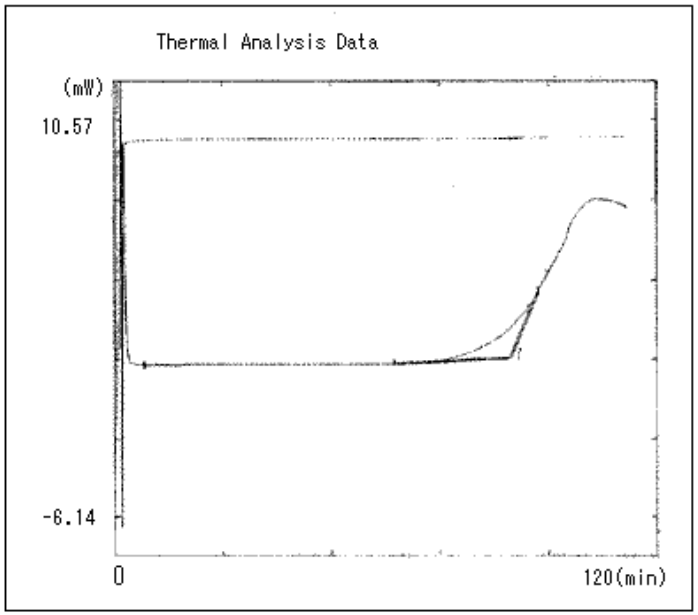

Fig.3 Oxidization of PE at 190°C

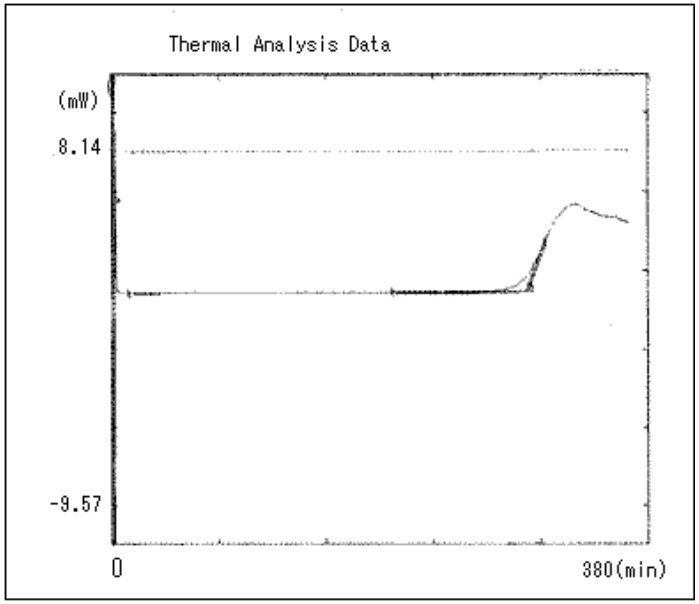

Fig.4 Oxidization of PE at 180°C

Catalysis of Cu

The phenomenon that polyethylene absorbs oxygen is largely enhanced by the presence of copper. Measurements similar to the above were taken in a temperature range from 200° C to 180° C, but the difference is that the sample cell used here was made of copper. Induction times at respective temperatures were shortened as shown by data below.

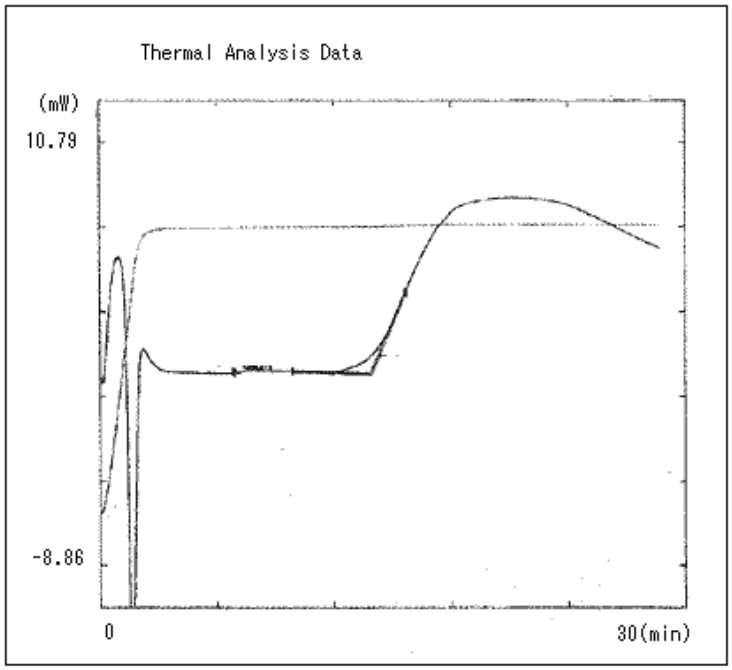

Fig.5 Oxidization of PE used Cu cell at 200°C

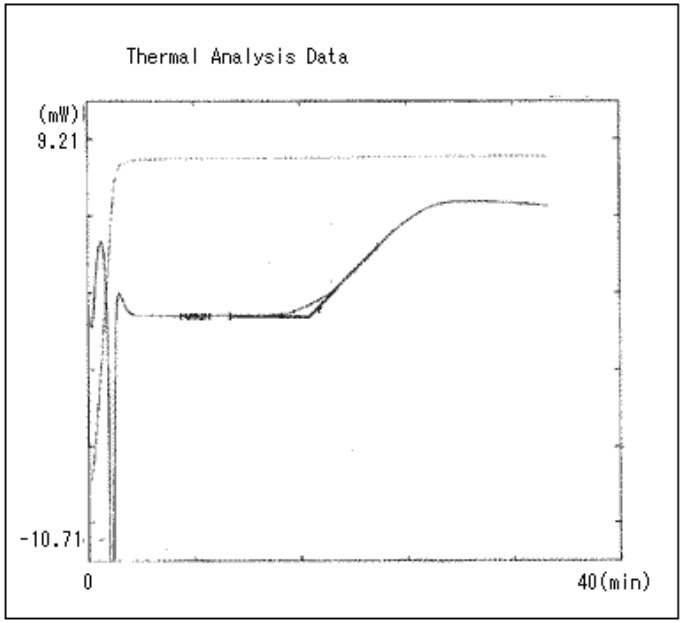

Fig.6 Oxidization of PE used Cu cell at 190°C

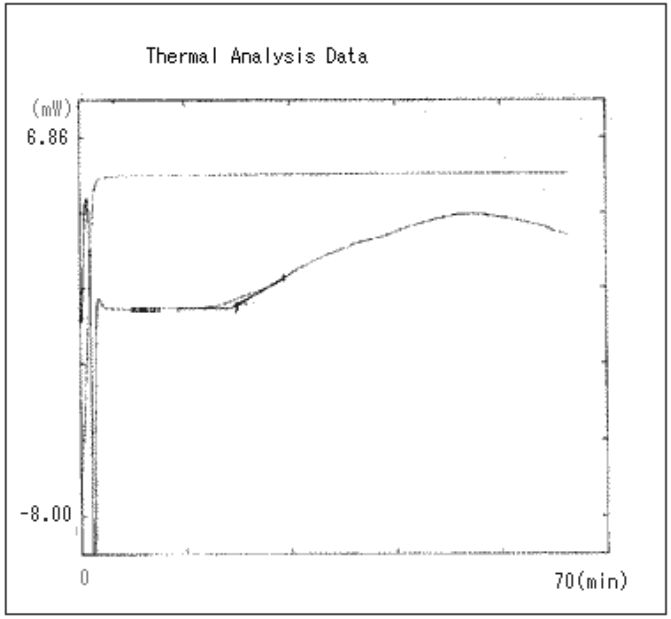

Fig.7 Oxidization of PE used Cu cell at 180°C

Arrhenius plot

The results obtained above were processed and represented in an Arrhenius plot, and activation energies were acquired based on gradients of straight lines. It is known that the copper acted as the catalyst.

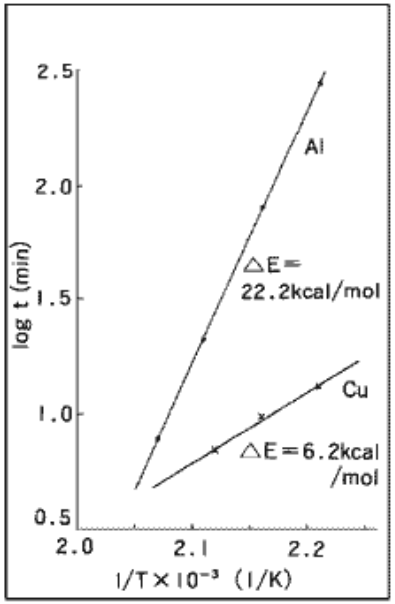

Fig. 8
Arrhenius plot of induction time

* Please be advised that data obtained before the implementation of the current Weights and Measures Law may be presented in terms of gravimetric unit.

SHIMADZU

SHIMADZU CORPORATION International Marketing Division
3,Kanda-Nishikicho 1-chome, Chiyoda-ku,Tokyo 101-8448,
JapanPhone: 81(3)3219-5641 Fax: 81(3)3219-5710
Cable Add,;SHIMADZU TOKYO

SHIMADZU SCIENTIFIC INSTRUMENTS, INC.
7102, Riverwood Drive, Columbia, Maryland 21046, U.S.A.
Phone: 1(410)381-1227 Fax: 1(410)381-1222 Toll Free:1(800)477-1227

SHIMADZU DEUTSCHLAND GmbH
Albert-Hahn-Strasse 6-10, D-47269 Duisburg, F.R. Germany
Phone: 49(203)7687-0 Fax: 49(203)7666-25

SHIMADZU (ASIA PACIFIC) PTE LTD.

16 Science Park Drive #01-01,Singapore Science Park, Singapore 118227, Republic of Singapore
Phone: 65-778-6280 Fax: 65-779-2935

SHIMADZU SCIENTIFIC INSTRUMENTS(OCEANIA)PTY. LTD.
Rydalmere Business Park, Unit T, 10-16, South Street Rydalmere, N.S.W. 2116, Australia
Phone: 61(2)9684-4200 Fax: 61(2)9684-4055

SHIMADZU DO BRASIL COMERCIO LTDA.
Rua Cenno Sbrighi, 25 CEP 05036-010 Agua Branca, Sao Paulo, BRAZIL
Phone: 55(11)3611-1688 Fax: 55(11)3611-2209

SHIMADZU (HONG KONG) LIMTED.
Suite 1028, Ocean Centre, Habour City, Tsim Sha tsui, Kowloon, HONG KONG
Phone: 852(2375)4979 Fax: 852(2199)7438

Overseas Office
Istanbul,Beijing,Shanghai,Guangzhou,Shenyang,Chengdu,Moscow