研 究 速 報

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# STUDIES ON THERMAL CONDUCTIVITY OF POLYMERS III

高分子の熱伝導度に関する研究III

—Thermal Conductivity of Poly (ethyleneterephthalate) by Schröder Method—

ポリエチレンテレフタレートの熱伝導度

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The thermal conductivity of poly(ethyleneterephthalate) was measured by Schröder method and the temperature dependence of the thermal conductivity in the range of the glass transition temperature was studied. The thermal conductivity was found to increase slightly with temperature in the region below about 90°C, and to begin decreasing abruptly at 90°C. This temperature revealing the maximum thermal conductivity agrees very closely with the glass transition temperature.

## Experimental

1) Material. The poly (ethyleneterephthalate) specimens used for this measurement were the disks of 23mm in diameter, 400$\mu$ in thickness and not elongated. They contained no additives.

2) Apparatus. The principle of the thermal conductivity measurement by Schröder method is as follows. A temperature difference is produced between the two sides of the sample disk by taking advantage of the two suitable liquids A and B with the different boiling points, then the quantity of heat flow through the sample is determined from the distilled quantity of the lower boiling liguid B. Further details of this method are referred to on the other papers[1,2]

The thermal conductivity $\lambda$ is given dy

$$\lambda=[Q/t(T_A-T_B)]\,l/C$$

where, $Q$ is the heat of vaporization required for 1 ml of liquid B, t is the time required for distilling 1 ml, $(T_A-T_B)$ is the temperature difference of the two liquids, $l$ is the thickness of the disk and c is the cross sectional area of the disk.

In this method, $\lambda$ can be determined from t, the time required for vaporization, measured with a stopwatch. In table 1, some suitable pairs of liquids used for this measurement are shown.

Table 1. Some suitable pairs of liquids

| Liquid A (°C) | Liquid B (°C) | $T_M$(°C)=$(T_A+T_B)/2$ |
|---|---|---|
| Acetone (56.3) | Carbon disulfide (46.3) | (51.3) |
| Ethanol (78.3) | Methanol (64.5) | (71.4) |
| Water (100.0) | Trichloroethylene (87.0) | (93.5) |
| n-Butanol (117.7) | Dioxane (101.3) | (109.5) |

## Results and Discussion

In Fig. 1, the thermal conductivity of poly (ethyleneterephthalate) was plotted against temperatures. In the region from 50°C to 90°C, the thermal conductivity values are on the order of $2.5\times10^{-4}$ cal/cm. sec. deg. and shows the tendency of slight increase

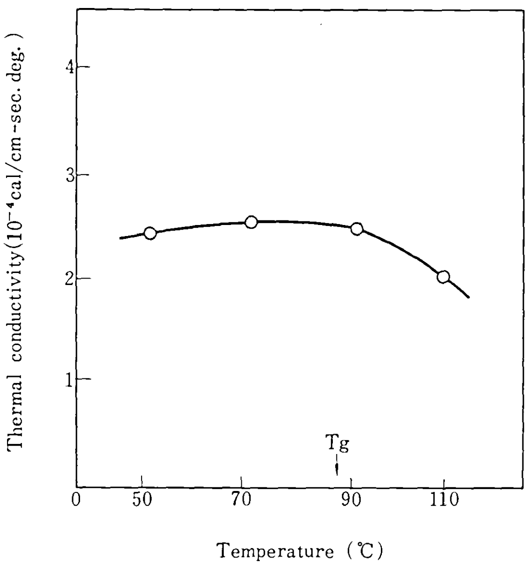


Fig. 1. Thermal conductivity of poly(ethyleneterephthalate).

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with temperature, whereas it decreases abruptly at 90°C, This temperature showing the maximum thermal conductivity agrees very closely wih the glass transition temperature Tg, 87°C, of poly (ethyleneterephthalate). This fact is considered to be due to the reduction of intermolecular forces resulting from rapid increase in mean intermolecular distances owing to dissolution of the frozen material above Tg.

Since poly(ethyleneterephthalate) is a crystalline polymer and is considered to be a so-called composite material in which the crystalline phase is dispersed in the amorphous phase, isolated treatments for both phases are necessary in the study of the temperature dependence of thermal conductivity in question.

In general, it is known that the thermal conductivity of amorphous polymer increases below Tg, and decreases above Tg with temperature, whereas that of crystalline polymers decreases with temperature. Despite its being a crystalline polymer, poly (ethyleneterephthalate) shows a feature of the temperature dependence similar to that of amorphous polymers. The interpretation on such behavior by Wada[3], which also includes examples of polypropylene and poly(chlorotrifluoroethylene), is that the complexity of the molecular structure is responsible for the similarity in the temperature dependence of thermal conductivities of both phases.

Eiermann[4] measured the thermal conductivity of poly(ethyleneterephthalate) in the range of temperature from -190°C to 60°C, and reported that the thermal conductivity of crystalline phase which had been separated increased with temperature in analogy with amorphous polymers. Therefore, it may be reasonable to consider the temperature dependence of the over-all thermal conductivity of poly (ethyleneterephthalate) shows the tendency similar to amorphous polymers.

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## References

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