Thermochimica Acta, 119 (1987) 231-232
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

THE THERMAL ANALYSIS OF PEEK

B. WUNDERLICH[1] and S.Z.D. CHENG[2]

[1]Department of Chemistry, Rensselaer Polytechnic Institut, Troy, NY 12180-3590 (USA). Present Address: Department of Chemistry, University of Tennessee, Knoxville, TN 37996-1600 (USA).

[2] Present Address: Department of Materials Science, University of Akron, Akron OH (USA)

SUMMARY

Poly(oxy-1,4-phenyleneoxy-1,4-phenylenecarbonyl-1,4-phenylene) (PEEK) is a relatively new macromolecule used as a high temperature polymer, especially as composite matrix. The discussion was based on the first full thermoanalysis. The heat capacity in the solid state (glass and crystal) from 0 K to the glass transition (419 K), respecitve to the melting transition (668 K) was computed using the vibrational spectrum and compared with measurements from 130 K to 650 K (agreement: better than ± 3 %, ref. 1) The heat capacity of the melt was measured from 420 to 650 K. All thermodynamic functions were determined (S, G, and H, ref. 2). Semicrystalline samples were characterized by determination of crystallinity and "rigid amorphous fraction" (ref. 3). The crystallinity was determined by the ratio to the measured ideal heat of fusion for the completely crystallized PEEK (37,5 kJ/mol). The rigid amorphous fraction was determined from the decrease of the increase of the heat capacity at the glass transition temperature 78.1 J/(Kmol) beyond the reduction caused by the crystallinity. Carefully annealed samples had a crystallinity and no rigid amorphous fraction. Increasingly quick cooled samples had increasing rigid amorphous fractions above the glass transition temperature (up to 14 %). In addition it was found that the glass transition temperature was increased to up to 430 K. The correlations between the three phases: liquid-amorphous, rigid-amorphous and crystalline were discussed in detail using many DSC-curves. Of importance are the changes in melting temperature and the occurrence of multiple melting peaks, the hysteresis of the amorphous regions, the change of heat capacity between glass and melting transition temperature, and the change of the melting curve as a function of crystallization time, temperature and annealing conditions.

This work was supported by the National Science Foundation of the US (Polymers Program, Grant Number DMR 83-17097). The presentation of the data at the 7. Ulmer Kalorimetrie Tage was possible through a Senior US Scientist Award of the Alexander von Humboldt Stiftung (B.W. 1987/88). Details have been published in the three references listed below.

REFERENCES

1 S.Z.D. Cheng, S. Lim, L.H. Indovits and B. Wunderlich.
Heat capacities of high melting polymers containing phenylene groups.
Polymer, to be published 1987.
2 S.Z.D. Cheng and B. Wunderlich. Heat capacities and entropies of liquid, high melting-point polymers containing phenylene groups (PEEK, PC and PET).
J. Polymer Sci., Polymer Phys. Ed. 24, 1755 (1986).
3 S.Z.D. Cheng, M.-Y. Cao and B. Wunderlich. Glass transition and melting of PEEK.
Macromolecules 19, 1868 (1986).