Study on Structure and Properties of Aliphatic Poly(carbonate)glycols and their Polyurethane Elastomers

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6. CONCLUSION.

PC-glycols with different methylene unit length were synthesized. Even number of the methylene unit length of PC-glycols (carbon number of the methylene unit was 4, 6 or 8 showed strong WAXD peaks and highly crystallized. On the other hand, odd number of the unit length of PC-glycols (carbon number of the methylene unit was 3 or 5 gave relatively weak WAXD peaks (PC-glycol 5002), or no crystalline peaks were observed (PC-glycol 3002).

Structural models of PC-glycols were investigated with computer simulation using WAXD data. PCD4002, PCD6002, PCD8002 and PCD10002 had crystal cell structure composed of four monomer unit with cell angle of $\alpha=60^\circ$, $\beta =90^\circ$ and $\gamma=90^\circ$.

On the other hand, unit cell of PCD5002, PCD7002 and PCD9002 composed of two-monomer unit due to the same direction of the carbonate group structure. These results indicate that differences of the even and odd number of methylene unit length affected the crystal structure of PC-glycol due to the arrangement of carbonate group direction.

Over methylene unit length nine, crystal structures were changed to the similar crystal structure of linear polyethylene. In this case, longer methylene unit dominate the crystal structure of PC-glycols due to the hydrogen bonding of increasing methylene unit.

Polyurethane Elastomers(PUEs) were synthesized with prepolymer method with MDI and 1,4-buthandiol. DSC measurement of the PUEs revealed that the microphase separation of PUEs became stronger if methylene unit number of
the PC-glycols decreased due to the increasing carbonate content in the soft segment.

Mechanical properties of the PC-glycol based PUEs were evaluated with tensile testing. Even number of the unit length of PC-glycols (carbon number of the methylene unit = 4, 6) based PUEs showed higher Young’s modulus and tensile strength and lower elongation at break due to the highly crystallized used PC-glycols. On the other hand, odd number of the unit length of PC-glycols (carbon number of the methylene unit = 3, 5) based PUEs gave relatively lower tensile strength and higher elongation. Also, no elongation-induced crystallization was observed. It was revealed that the mechanical properties as well as micro phase separation of the PC-glycols based PUEs are controllable by changing the number of methylene chain length of the PC-glycols. Especially, it was found that in order to obtain softer PUEs, to select the PC-glycols, which had add number methylene unit length, was effective.

Randomly copolymerized PC-glycols, which have BD and HD units between carbonate groups in various composition ratios (BD/HD = 0/100, 50/50, 70/30, or 90/10) and two different molecular weights (1000 and 2000) were employed for the synthesis of PUEs. The PC-glycols with composition ratios of BD/HD=50/50 and 70/30 were in the liquid state, whereas those with 100/0 and 0/90 ratios were in the solid state, at 20°C. In particular, PC-glycol with a 100/0 ratio, which was composed of only one component, was in the crystalline state.
The PUEs were synthesized with PC-glycols, MDI and BD as a hard segment component by a prepolymer method.

DSC measurements revealed that the microphase separation of the PUEs became stronger with an increasing BD composition ratio.

With an increasing BD composition ratio, the hardness and Young’s modulus of the PUEs increased because of increases in the degree of microphase separation and stiffness of the PC-glycol. Changes in the slope in the region in which elongation-induced crystallization occurred in tensile testing showed a minimum around a BD/HD = 50/50 composition ratio. This was explained by the irregularity of the methylene unit of the PC-glycols. The 1000 series and 2000 series PUEs showed similar trends. The addition of different methylene chain units to the PC-glycols was found to be quite effective for controlling the microphase separated structure and mechanical properties of the PUEs.
REFERENCES

5. ASAHI KASEI CHEMICALS Technical Catalog
17. Masubuchi, T, コーティング時報 No.218 PP.6-12(2004) (1, 2章)

LIST OF PUBLICATION

(1) Aliphatic Poly(carbonate) Glycols with Different Length of Methylene Unit and Their Polyurethane Elastomers, Tetsuo Masubuchi, Ken Kojio, Mutsuhisa Furukawa; Proceedings of API Polyurethanes 2006 Technical Conference pp.16-23 (2006) (Chapter 2, 3, 4)


(5) 増渕徹夫、コーティング時報 No.218 PP.6-12 (2004) (5章)

1-2 印刷公表予定論文

(1) Tetsuo Masubuchi, Machiko sakai, Ken Kojio, Mutsuhisa Furukawa, Poly(carbonate) Glycols with Different Methylene Unit Length, e-J Soft Materials, 投稿中 (2, 3 章)

(2) 共重合ポリカーボネートジオールの凝集構造と力学物性, 増渕徹夫, 接着の技術 (日本接着学会) 投稿中 (5 章)
BIographies

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Tetsuo Masubuchi is a student of Graduate School of Science and Technology at Nagasaki University since 2004. He received his B.S. (1980) and M. Eng., degree (1982) in Applied Chemistry from Waseda University. He joined ASAHI KASEI Ind., Co., Ltd., in 1982. He received the Award for Technical Development from The Chemical Society of Japan in 1995, in regard to the development of new hydrogenation catalyst system for styrene butadiene block copolymer. His research interests include synthesis and analysis of molecular structure of polymers, especially thermoplastic elastomers. Since 1999, he has been in charge of Research & Development of polycarbonate diols in ASAHI KASEI CHEMICALS. Co., Ltd., and became general manager of PCD business group in 2006.