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BY X-RAY DIFFRACTION**

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BY X-RAY DIFFRACTION**

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Preface

The subjects of this book largely include reviewed works of the Laboratory of Polymer Science (LPS) of the Department of Physics, Faculty of Science, Shizuoka University, Japan. Most of the research studies presented in this book embrace polymer morphology that was extensively observed by the X-ray diffraction (XD) method and partly by the microhardness (MH) technique. Therefore, the authors have incorporated both the theoretical and experimental explanations for the basic understanding of XD and MH techniques in chapters 1-3 and 9, respectively.

In the first chapter, the authors describe the crystal structure and lattice planes. The relationship between X-ray diffraction and the reciprocal lattice is explained by the Ewald sphere construction. In the second chapter, the authors discuss how the scattering intensity is calculated by Fourier transform of the electron density. It is worthy to note that most of the diffraction phenomena can be explained based on the Fourier transform and further by the convolution theory, which they have also introduced. In the third chapter, the authors show experimental techniques which were developed for the X-ray diffraction measurements. The fundamental explanations presented in these three chapters will provide suitable help for master students who are starting the X-ray diffraction measurement. The authors hope that this book will provide good instruction on these topics.

In chapters 4-10, the authors explain their survey on the polymer morphology. The fourth chapter is concentrated on the crystallization of poly(ethylene terephthalate) (PET), which T. Asano has studied from the beginning of his research at LPS. The fifth chapter deals with the temperature slope crystallization (TSC) that is a unique technique of polymer crystallization. The TSC instrument was mostly developed by Y. Fujiwara and then furnished and coupled with other technical methods by T. A. for performing advanced research. Using various polymers such as polyethylene (PE), polypropylene (PP) etc., they prepared oriented textures by TSC and used them in the structural and/or thermodynamic studies.

M. F. Mina started his research work on paraffin and PE at LPS in 1994. He concentrated his studies on transient phenomena of various phases of hexatriacontane (C₃₆) in his doctoral dissertation. Besides that he collaborated with the investigation into the phase transition of PP, PET and other polymers. The results of C₃₆ are summarized in chapter 6. Polymer deformation is also an important work of LPS. Employing the TSC method, the authors explain precise observations during the deformation of oriented PP. Chapter 7 deals with the results of roll deformation of PP and the shrinkage behavior of PET.

T. A. stayed in Hamburg, Germany from July, 1986 to February, 1988 and worked mainly at DESY and TUHH. He worked with the crystallinity measurements of PET with Prof. H. G. Zachmann and epitaxial crystallization with Prof. J. Petermann. The results of these research works are described in chapters 8 and 10. Moreover, he started his collaboration with Prof. F. J. Baltá Calleja from 1987. The results obtained by these collaborative works, using MH measurements and X-ray analyses, are explained in chapters 4 and 9.

In 1999, after the celebration of the doctorate of M. F. M, the authors planned to publish a book of their collective works carried out over three generations (Y. F – T. A – M. F. M). However, T. A and M. F. M were disheartened that their plan could not be realized after the death of Prof. Fujiwara in 2004. At that time, he had published a book titled “A Survey of Temperature Slope Crystallization (TSC) for the Oriented Crystallization of Polymer Lamellae”. The cover page of his book was green, and hence called a ‘green book’ that was used as a model book in seminars on LPS. He gave all the rights and responsibilities of the green book to the other two authors who then might use the results of TSC in any new book. At present, residuals of the green book are very few in LPS. Then, according to the above agreement and with cordial thanks to Prof. Fujiwara, the other two authors have decided to incorporate a copy of the green book at the end of this book.

The authors are greatly indebted to the Professors of Shizuoka University, who cooperated in the polymer research or X-ray diffraction studies, especially, Profs. T. Yoshida, M. Yamazaki, C. Sawatari and H. Itagaki. They are profoundly grateful to Prof. F. J. Baltá Calleja for his continuous collaboration and kind invitations to his laboratory in Madrid, Spain.

T. A. would like to send his sincere gratitude to the late Prof. H. G. Zachmann and the late Prof. J. Petermann for their kind invitation to Hamburg and continuous encouragements. T. A gives cordial thanks to all Professors and Doctors; T. Seto, H. Tanaka, M. Hikosaka, S. Toki, A. Würflinger, S. Polizzi, G. Broza, S. Yan and P. Johnson for their friendly and warm cooperation during the extent of his research. M. F. M thanks JSPS and Shizuoka University for awarding scholarships and facilitating his Ph. D work. They together express thanks to all students who worked in LPS.

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The authors are indebted to their wives and children for their fundamental, sympathetic and enthusiastic support throughout their research and preparation of this book.

Finally, the authors beg pardon if there is any mistake found during the reading of this book even though they have given their utmost efforts to prevent errors. The authors will, of course, be grateful if they receive suggestions from the readers for further improvement of the book.

Shizuoka, Dhaka, March 2006

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M.F. Mina