Glass Transition, Dynamics and Heterogeneity of Polymer Thin Films

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1. Auflage 2012. Buch. viii, 144 S. Hardcover
ISBN 978 3 642 34338 4
Format (B x L): 15,5 x 23,5 cm
Gewicht: 397 g

Preface

State-of-the-art nanotechnology aims at producing functional nano-sized devices which require stable, homogeneous, and uniform polymer films in the nanometer scale. This need has been driving extensive studies of polymer thin films for more than a decade. Such films possess interesting but unusual properties such as anomalous film thickness dependence of the glass transition temperature Tg and thermal expansivity; they also display very large annealing effects and ultraslow relaxation in the molten and glass states. Unusual film thickness dependence of the glass transition temperature Tg has often been discussed in terms of quasi-multilayer structures consisting of, at least, a surface mobile layer, a middle bulk-like layer, and a bottom interface layer on a substrate, showing quasi-multilayer structures or the heterogeneous structure of polymer thin films.

In this special volume we focus our attention on recent studies of the glass transition, dynamics, and heterogeneity in polymer thin films using various experimental techniques to shed light on the present status of the research as well as future issues to be investigated. The volume includes studies on surface and interface glass transition temperatures of polymer thin films on solid substrates investigated by scanning force microscopy and fluorescence lifetime measurements, respectively, revealing the distribution of glass transition temperatures in the depth direction. Neutron scattering experiments on polymer thin films are also included in the volume, revealing the heterogeneous dynamics and the distribution of glass transition temperatures. Another topic is the effect of the preparation of polymer thin films on their properties. Residual stresses, arising from out-of-equilibrium chain conformations due to rapid solvent loss during the thin film preparation, was studied by visco-elastic dewetting of thin films. Aging dynamics of single and stacked thin polymer films is also investigated by differential scanning calorimetry and dielectric relaxation spectroscopy, showing the heterogeneous dynamics of polymer thin films.

The most important message in the volume is that the heterogeneity in polymer thin films is a key to understand their atypical properties although we still have many unsolved problems. In any case we hope that this special volume contributes to the development of polymer thin films in physics in future.

Finally, we are indebted to all people contributing to this special volume. Special thanks to Professor Akihiro Abe who gave me an opportunity to edit the volume and Ms Karin Bartsch and Dr Tobias Wassermann for continuous assistance to edit the volume.

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August 2012