Arabinda Ghosh

Technology of Polymer Packaging



HANSER

Arabinda Ghosh **Technology of Polymer Packaging**

Technology of Polymer Packaging

The Author:

Prof. Dr.-Ing. Arabinda Ghosh, University for Applied Sciences, Stuttgart (HdM), Nobelstr. 10, 70569 Stuttgart, Germany

Distributed in North and South America by: Hanser Publications 6915 Valley Avenue, Cincinnati, Ohio 45244-3029, USA Fax: (513) 527-8801

Phone: (513) 527-8977 www.hanserpublications.com

Distributed in all other countries by Carl Hanser Verlag Postfach 86 04 20, 81631 München, Germany Fax: +49 (89) 98 48 09 www.hanser-fachbuch.de

The use of general descriptive names, trademarks, etc., in this publication, even if the former are not especially identified, is not to be taken as a sign that such names, as understood by the Trade Marks and Merchandise Marks Act, may accordingly be used freely by anyone. While the advice and information in this book are believed to be true and accurate at the date of going to press, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with re-

spect to the material contained herein.

The final determination of the suitability of any information for the use contemplated for a given application remains the sole responsibility of the user.

Cataloging-in-Publication Data is on file with the Library of Congress

Bibliografische Information Der Deutschen Bibliothek Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying or by any information storage and retrieval system, without permission in writing from the publisher.

© Carl Hanser Verlag, Munich 2015

Editor: Cheryl Hamilton

Production Management: Jörg Strohbach

Coverconcept: Marc Müller-Bremer, www.rebranding.de, München, Germany

Coverdesign: Stephan Rönigk

Printed and bound by Hubert & Co GmbH, Göttingen, Germany

Printed in Germany

ISBN: 978-1-56990-576-0 E-Book ISBN: 978-1-56990-577-7

In Memory of

My parents

and

The legendary
Professor Dr.-Ing. habil. h. c. Rudolf Heiss
1903–2009

(Director of the Fraunhofer Institute for Food and Packaging Technology, Munich 1936–1975)

Preface

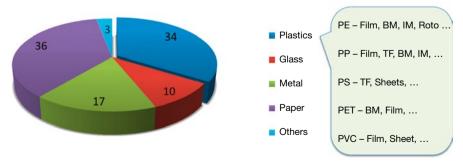
Since the first production of polyethylene on a large scale by ICI (Imperial Chemical Industries) in the 1930s, polymer materials, or as they are simply called, plastics, have been inevitable as successful packaging materials. Plastics protect all kinds of products like food, pharmaceuticals, cosmetics, medical products, and other nonfoods against deterioration. Although the amount of tissue material such as paper, paper board, and corrugated board used for packaging is a bit higher than polymers, polymers are inevitable for primary packaging. They fulfill all of the legislative regulations worldwide for direct contact with the product, particularly with food.

No other packaging material shows such a continuous and rapid development as does polymer packaging material. Scientists, experts, and technologists of the packaging sector are responsible for the development and application of tailor-made solutions. This book will contribute to the practical knowledge of specialists.

Besides basic and applied knowledge on technology, a number of valuable suggestions on critical cases are given in this book.

Finally, I hope this book will be a valuable help for the reader to solve technical problems and be a contribution to successful packaging development.





Plastics Have the Highest Growth Rate among All Materials in the Packaging Sector

BM: blow molding, IM: injection molding, TF: thermoforming, Roto: roto molding Raj Datta, Haldia Petrochemicals, National Conference, IIP, Kolkata 2012

Acknowledgements

I want to express my acknowledgement to a number of people in the packaging industries of Germany, Switzerland, and Belgium for their valuable information and kind permission to publish relevant information or figures.

For valuable information:

Mrs. Elisabeth Mersteiner, RPC Kutenholz, Germany

Dr. Alfred Koblischek, Alcan-Tscheulin, Germany

Dr. Karl-Heinz Hausmann, DuPont, Switzerland

Mr. Helmut Meyer, Reifenhauser, Germany

Mr. Herbert Stotkiewitz, Bosch Packaging, Germany

Mr. Harald Braun, Rovema, Germany

Mr. Matthias Huter, Solvay, Germany

Mr. Matthias Schraegle, Huhtamaki, Germany

Mr. Peter Ludwig, EK-Pack, Germany

Mr. Raj Datta, Haldia Petrochemicals, India

Dr. Christof Herschbach, Windmoeller & Hoelscher, Germany

Dr. Sven Fischer, Krones, Germany

Dr. Georg Kinzelmann, Henkel, Germany

For figures:

Dr. Michael Roth, Battenfeld, Germany

Mr. William Reay, Kuraray, Belgium

Mr. Herbert Stotkiewitz, Bosch Packaging, Germany

Mr. Matthias Huter, Solvay, Germany

Otto Hofstetter AG, CH – Uznach, Switzerland

Contents

Pre	faceV	П
Acl	knowledgements I	X
Coı	ntentsX	I
Abl	previations X	V
1	Basics of Polymer Packaging	1
1.1	Definition of Polymers	1
1.2	Manufacturing of Polymer Resins	1
1.3	Classification of Plastics: Molecular Structure	3
1.4	Plastics Additives 1.4.1 Usual Additives in the Packaging Sector 1.4.1.2 Light Stabilizer 1.4.1.3 PVC Stabilizer 1.4.1.4 Antiblock Agents 1.4.1.5 Antifog Agents 1.4.1.6 Nucleating Agents 1.4.1.7 Lubricants as Processing Aids 1.4.1.8 Slip Agents 1.4.1.9 Antistatic Agents 1.4.1.10 Colorants 1.4.1.11 Optical Brighteners 1.4.1.12 Chemical Blowing Agents 1.4.1.13 Antimicrobial Agents	5 5 5 6 6 6 6 6 7 7 7 8
1.5	Required Performance of Polymer Packaging	
	Different Types of Polymers Used for Packaging	9

1.7	Short Description of Some Polymers for Packaging Applications	12
1.8	Major Polymers Used in Packaging	16
	1.8.1 Important Points for the Technologist	
Refe	erences	17
2	Manufacturing of Polymer Packaging	19
2.1	Extrusion of Resins	19
	2.1.1 Technology of Extrusion	20
	2.1.2 Continuous Processes	26
	2.1.2.1 Manufacturing of Blown Film	26
	2.1.2.2 Manufacturing of Cast Film	30
	2.1.2.3 Collapsible Tubes	34
	2.1.2.4 Flexible Films for Packaging	39
	2.1.3 Important Features for the Technologist	48
	2.1.4 Discontinuous Processes	49
	2.1.4.1 Injection Molding (IM)	49
	2.1.4.2 Injection Blow Molding (IBM)	52
	2.1.4.3 Extrusion Blow Molding (EBM)	54
	2.1.4.4 Stretch Blow Molding (SBM)	56
	2.1.4.5 Different Types of PET	60
	2.1.4.6 Thermoforming	60
2.2	Sealing of Packages	71
	2.2.2 Principles of Heat Generation for Sealing of Packaging Materials	73
	2.2.3 Technology of Sealing	
	2.2.3.1 Direct Heating Systems	
	2.2.3.2 Indirect Heating Systems	
Refe	erences	
3	Converting of Polymer Packaging (Composite Packaging)	83
3.1	Technology of Converting	83
	3.1.1 Modes of Converting Packaging Material	84
	3.1.2 Technology of Coating	85
	3.1.2.1 Extrusion and Coextrusion Coating	85
	3.1.2.2 Coating with Lacquer	86
	3.1.2.3 Coating with Polymer Dispersion	88
	3.1.3 Technology of Lamination	89
	3.1.3.1 Extrusion and Coextrusion Lamination	90
	3.1.3.2 Dry Lamination, Solvent Based	91
	3.1.3.3 Dry Lamination, Solvent-Free Adhesive	