

Susheel Kalia · Shao-Yun Fu *Editors*

# Polymers at Cryogenic Temperatures

 Springer

*Editors*

Susheel Kalia  
Dept. of Chemistry  
Bahra University  
Himachal Pradesh  
India

Shao-Yun Fu  
Chinese Academy of Sciences  
Technical Institute of Physics and Chemistry  
Beijing  
China, People's Republic

ISBN 978-3-642-35334-5 ISBN 978-3-642-35335-2 (eBook)

DOI 10.1007/978-3-642-35335-2

Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013935213

© Springer-Verlag Berlin Heidelberg 2013

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, 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 respect to the material contained herein.

# Contents

|   |     |
|---|-----|
| <b>1 Cryogenic Processing: State of the Art, Advantages and Applications</b> . . . . .  | 1   |
| Susheel Kalia and Shao-Yun Fu   |     |
| <b>2 Cryogenic Properties of Polymer Materials</b> . . . . .  | 9   |
| Shao-Yun Fu   |     |
| <b>3 Friction and Wear of Polymer Materials at Cryogenic Temperatures</b> . . . . .   | 41  |
| Géraldine Theiler and Thomas Gradt  |     |
| <b>4 Mechanical Behavior of Polymer Composites at Cryogenic Temperatures</b> . . . . .  | 59  |
| Sanghamitra Sethi and Bankim Chandra Ray  |     |
| <b>5 Interlaminar Delamination Fracture and Fatigue of Woven Glass Fiber Reinforced Polymer Composite Laminates at Cryogenic Temperatures</b> . . . . . | 115 |
| Yasuhide Shindo, Tomo Takeda, and Fumio Narita  |     |
| <b>6 The Behavior of Polymer-Based Dielectrics Under Cryogenic Conditions</b> . . . . .   | 127 |
| H. Rodrigo  |     |
| <b>7 Medical Applications of Poly(vinyl alcohol) Cryogels</b> . . . . .   | 147 |
| S. Reiter, R. Mongrain, M. Abdelali, and J.-C. Tardif   |     |
| <b>8 Dielectric Properties of Polymers at Low Temperatures</b> . . . . .  | 161 |
| Luís Cadillon Costa and François Henry  |     |
| <b>9 Influence of Cryogenic Treatment on Mechanical Behavior of Glass Fiber-Reinforced Plastic Composite Laminate</b> . . . . .                         | 181 |
| C.G. Sreenivasa and Ajith. G. Joshi   |     |

|   |            |
|---|------------|
| <b>10 Polyurethane and Polyisocyanurate Foams in External Tank<br/>Cryogenic Insulation . . . . .</b> | <b>203</b> |
| U. Stirna, I. Beverte, V. Yakushin, and U. Cabulis  |            |
| <b>11 Cryogenic Treatment of Materials: Cutting Tools<br/>and Polymers . . . . .</b>                  | <b>245</b> |
| Simranpreet Singh Gill and Harpreet Singh   |            |
| <b>12 Current and Potential Applications of Cryogenic<br/>Treated Polymers . . . . .</b>              | <b>275</b> |
| Paolo Baldissera and Cristiana Delprete   |            |
| <b>About the Editors . . . . .</b>  | <b>287</b> |
| <b>Index . . . . .</b>  | <b>289</b> |