

# GREEN CHEMISTRY

Fundamentals and Applications

Editors

Suresh C. Ameta

Rakshit Ameta



Apple Academic Press



CRC Press

Taylor & Francis Group

|   |  |   |
|---|--|---|
| Apple Academic Press Inc.<br>3333 Mistwell Crescent<br>Oakville, ON L6L 0A2<br>Canada |  | Apple Academic Press Inc.<br>9 Spinnaker Way<br>Waretown, NJ 08758<br>USA |
|---|--|---|

©2014 by Apple Academic Press, Inc.

*Exclusive worldwide distribution by CRC Press, a member of Taylor & Francis Group*

No claim to original U.S. Government works

Printed in the United States of America on acid-free paper

International Standard Book Number-13: 978-1-926895-43-7 (Hardcover)

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission and sources are indicated. Copyright for individual articles remains with the authors as indicated. A wide variety of references are listed. Reasonable efforts have been made to publish reliable data and information, but the authors, editors, and the publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors, editors, and the publisher have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged, please write and let us know so we may rectify in any future reprint.

**Trademark Notice:** Registered trademark of products or corporate names are used only for explanation and identification without intent to infringe.

**Library of Congress Control Number: 2013945482**

---

### Library and Archives Canada Cataloguing in Publication

---

Green chemistry: fundamentals and applications/edited by Suresh C. Ameta and Rakshit Ameta.

Includes bibliographical references and index.

ISBN 978-1-926895-43-7

I. Environmental chemistry. 2. Environmental chemistry--Industrial applications.

I. Ameta, Suresh C., author, editor of compilation II. Ameta, Rakshit author, writer of introduction, editor of compilation

TP155 .2.E58G74 2013

660

C2013-904995-9

---

# CONTENTS

---

|  |             |
|--|-------------|
| <i>List of Contributors</i> .....  | <i>ix</i>   |
| <i>List of Abbreviations</i> .....                                       | <i>xiii</i> |
| <i>Preface</i> .....   | <i>xvii</i> |
| <b>1. Introduction</b> .....   | <b>1</b>    |
| Rakshit Ameta  |             |
| <b>2. Benign Starting Materials</b> .....                                | <b>9</b>    |
| Sanyogita Sharma, Neelam Kunwar, Sangeeta Kalal, and P. B. Punjabi       |             |
| <b>3. Eco-Friendly Products</b> .....                                    | <b>43</b>   |
| Neelu Chouhan, Anil Kumar, Ajay Sharma, and Rameshwar Ameta              |             |
| <b>4. Green Catalysts</b> .....  | <b>87</b>   |
| Shikha Panchal, Yuvraj Jhala, Anuradha Soni, and Suresh C. Ameta         |             |
| <b>5. Ionic Liquids: Promising Solvents</b> .....                        | <b>109</b>  |
| Arpit Pathak, Nirmala Jangid, Rakshit Ameta, and P. B. Punjabi           |             |
| <b>6. Supercritical Fluids</b> .....                                     | <b>137</b>  |
| Abhilasha Jain, Shikha Panchal, Shweta Sharma, and Ramashwar Ameta       |             |
| <b>7. Other Green Solvents</b> .....                                     | <b>161</b>  |
| Abhilasha Jain, Ritu Vyas, Aarti Ameta, and P. B. Punjabi                |             |
| <b>8. Photocatalysis: An Emerging Technology</b> .....                   | <b>199</b>  |
| Indu Bhati, Paras Tak, H. S. Sharma, and Rakshit Ameta                   |             |
| <b>9. Photo-Fenton Reactions: A Green Chemical Route</b> .....           | <b>225</b>  |
| Surbhi Benjamin, Noopur Ameta, P. B. Punjabi, and Suresh C. Ameta        |             |
| <b>10. Sonochemistry: A Pollution Free Pathway</b> .....                 | <b>255</b>  |
| Garima Ameta, Surbhi Benjamin, Vikas Sharma, and Shipra Bhardwaj         |             |
| <b>11. Microwave Assisted Organic Synthesis: A Need of the Day</b> ..... | <b>283</b>  |
| Chetna Ameta, K. L. Ameta, B. K. Sharma, and Rajat Ameta                 |             |
| <b>12. Green Composites</b> .....  | <b>317</b>  |
| Yasmin, N. P. S. Chauhan, and Rohit Ameta                                |             |

|  |            |
|--|------------|
| <b>13. Green Manufacturing Processes .....</b>     | <b>353</b> |
| Jitendra Vardia, Dipti Soni, and Rakshit Ameta     |            |
| <b>14. Present Scenario and Future Trends.....</b> | <b>367</b> |
| Suresh C. Ameta                                    |            |
| <b>Index .....</b>                                 | <b>371</b> |