Process Modeling in Composites Manufacturing

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MANUFACTURING ENGINEERING AND MATERIALS PROCESSING
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to our families:

Yolanda Chetwynd, Madhu and Diana Advani;
and
Hanife, Zehra and Eray Sozer.
Preface

Properties and performance of products made from fiber reinforced composites depend on materials, design, and processing. This book is about polymer composites processing. Three decades ago our understanding of mass, momentum, and energy transfer during composites processing was nonexistent. As a result, almost all manufacturing was based on experience, intuition and trial and error. We have come a long way since then. Many researchers did delve into this difficult and poorly understood area to uncover the physics and chemistry of processing and to develop the fundamental and constitutive laws to describe them.

There is currently a wealth of literature on modeling and simulation of polymer composite manufacturing processes. However, we felt that there was a need to systematically introduce how one would go about modeling a composite manufacturing process. Hence, we focused on developing a textbook instead of a researcher's reference book to provide an introduction to modeling of composite manufacturing processes for seniors and first-year graduate students in material science and engineering, industrial, mechanical, and chemical engineering. We have explained the basic principles, provided a primer in fluid mechanics and heat transfer, and tried to create a self-contained text. Many example problems have been solved to facilitate the use of back-of-the-envelope calculations to introduce a scientific basis to manufacturing. The end of each chapter has questions and problems that reinforce the content and help the instructor. “Fill in the Blanks” sections were created by Murat Sozer to add to the qualitative knowledge of process modeling of composites manufacturing that will develop the “experience base” of the manufacturing, materials, and design engineer or scientist.

A project of this magnitude obviously cannot be realized without the help of others. First, we thank Mr. Ali Gokce, graduate student at the University of Delaware, who created many of the graphics in this book. Diane Kukich helped in technical editing. Of course we thank all the graduate students in our research group who over the years have helped create the research and the science base to develop models of composite manufacturing processes. We would especially like to mention Petri Hepola, Steve Shuler, Terry Creasy, Krishna Pillai, Sylvia Kueh, Simon Bickerton, Hubert Stadtfeld, Pavel Nedanov, Pavel Simacek, Kuang-Ting Hsiao, Gonzalo Estrada, Jeffery Lawrence, and Roopesh Mathur. Some of the examples and figures used in the book were first developed with their help.

The book contains eight chapters. The first two introduce the composite materials and manufacturing processes. Chapters 3–5 provide the tools needed to model the processes, and Chapters 6–8 apply these tools to some of the well known manufacturing processes.
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