Preface

This book is intended for readers, especially early research students, who wish to apply the basic principles of stress transfer and fracture in discontinuous fibre-reinforced composites (DFRCs) to evaluate how the fibre takes up stress and how the DFRC can fail and fracture. The science and technology landscape of fibre-reinforced composites has seen rapid advancement over the past 20 years, and many important basic discoveries have been reported. The contemporary composite scientists as well as engineers may be aware of many of these new developments but ensuring that their understandings reflect this is, in essence, the key motivation for writing this book.

To this end, in order for the researcher to understand how fibres provide reinforcement to the composite material, the researcher needs to be familiar with the underlying principles involved in each stage of the loading process. A discussion of the preliminary concepts appears in the first two chapters of the book. The concepts are further developed in subsequent chapters to explain the ways in which stress transfer occurs, when the fibre and matrix change from elastic to plastic states, at different stages of the loading process, until the composite ruptures. The final chapter highlights the applicability of the concepts for DFRC design considerations and a novel approach to integrate the concepts into a framework. The conceptual framework could be useful for driving further theoretical development, as well as for practical applications relating to the design of DFRCs and to the development of new DFRCs. Throughout the book, the explanations are kept terse in an attempt to avoid boring readers with a strong theoretical background, particularly in the strength of materials as well as in the physics and chemistry of materials. Similarly, some mathematical arguments are supplemented with descriptions in words. Nevertheless, mathematical arguments are presented wherever the need for a concise explanation arises. References to other sources which have been found to be particularly useful to the author are cited in the main text and listed in the reference section at the end of this book; it is not intended to be comprehensive.

A book of this kind is now realized only because of the pioneering work of distinguished scientists and engineers, namely Bhagwan D. Agarwal, Lawrence J. Broutman, Alan Cottrell, H.L. Cox, Anthony Kelly, Yiu-Wing Mai and Michael Piggott. Many colleagues and friends have also influenced this book. My ideas owe much to the influence of David Hukins who inspired me to develop new concepts drawn from biological systems for engineering composite materials and taught me the value of presenting complicated models with simple mathematical formulations complemented by descriptions in words. Peter Purslow taught me the value of micromechanical testing; our collaborative research has also influenced the conceptual design of micromechanical instruments for fibre testing for the analysis of stress transfer and fracture. Tim Wess taught me the value of interrogating experimental data using parameterized computer models based on stochastic approach; our collaborative research has also influenced the development of the multiscale composite model for the analysis of stress transfer and fracture from stress–strain data. Conversations with Geoff Gibson helped me to understand more about the practical design, application and repair of fibre composite in mission critical areas in aerospace engineering. Collaboration with Pooria Pasbakhsh helped me to appreciate the sensitivity of the mechanical properties of nanofibre-reinforced composites to processing methodologies. I am also particularly grateful to colleagues from the Mechanical Design & Manufacturing Engineering programme at Newcastle University, and research students, past and present, in my research group who have facilitated my understanding of fibre-reinforced composite materials. Finally, I am grateful to the editors at Springer for their patience and understanding.

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Kheng Lim Goh

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