Preface

One of the definitions of primer (**prim′·er**) is that it is a textbook that gives the first principles of any subject (Webster 1962). In light of the nature of the material that follows, it is thus appropriate to refer to this as a primer. The reason for writing this primer is to provide a vehicle for engineers who may need to apply this technology but are not well versed in the underlying theory, nor aware of some of the limitations associated with the application.

The material covered herein was explored during the period July 1, 2005, through December 31, 2012, during which time I was engaged as a consultant by ERC Incorporated in Huntsville, Alabama, to perform services as directed by the Weapons Development and Integration (WDI) Directorate of the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), US Army Research, Development, and Engineering Command at Redstone Arsenal, Alabama. A large portion of the services I performed related directly to the formulation of models to simulate the response and behavior of solid propellant material systems.

The subjects presented cover a sufficiently broad range of topics that define hyperelasticity. The material is, by and large, introductory in nature, but probes the subjects in some depth in most cases. It is developed to be understood and useable by engineers who understand and are able to employ the principles of mechanics. An important aspect of the presented material is that a number of illustrative numerical examples are included. This usually serves well to soften the bluntness of new, to the reader, and challenging theoretical material. The coverage focuses on the topics of *finite elasticity*, *strain-energy functions*, *polar decomposition*, *strain measures*, *stress measures*, *tangent moduli*, *conjugate pairs*, *incrementation*, *objectivity*, *finite viscoelasticity*, and *finite element implementation*. In addition to these topics, some emphasis is placed on obtaining *model parameters from test data*. Most emphasis is placed on, and coverage given to, the topic of incrementation, since this is how we all solve mechanics problems today.

Jeremy R. Rice, an employee and a team leader in the WDI Directorate and a Ph.D. candidate at the University of Alabama in Huntsville (UAH) at the time that

I worked there, made innumerable invaluable suggestions relative to the development of this monograph. Robert R. Little, Chief of Missile Sustainment of the WDI Directorate, made available the funding that supported my work, for which I am especially grateful. Numerous discussions with Q.H. Ken Zuo, Associate Professor in the Department of Mechanical and Aerospace Engineering (MAE) at UAH, were also extremely beneficial.

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Deep appreciation is expressed to Michael Luby, Senior Editor, Physical Sciences and Engineering, who has provided exceptional direction, support, and encouragement from the very beginning of the undertaking to publish this monograph, and to Brinda Megasyamalan, Project Coordinator, Production Editor (Books), who has continuously coordinated the project activities, providing most helpful information and feedback on the process at every step.

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