Ballistic Simulation

Ballistic composites need to be lightweight and durable as well as exhibiting high impact resistance and damage tolerance. This important book reviews these requirements, how the materials used for ballistic composites meet them and their range of applications. After an introductory chapter, Lightweight ballistic composites is split into two main sections. The first part of the book explores material requirements and testing. There are chapters on bullets and bullet fragments, material responses to ballistic impact, standards and specifications, modelling and test methods. Part Two reviews the range of materials used, production methods and applications. Topics discussed include high-performance ballistic fibres and ceramics, non-woven ballistic and prepreg composites, and their uses in body armour, vehicle and aircraft protection. This major book is the first of its kind to give a comprehensive review of the current use of lightweight ballistic composites in both military and law-enforcement applications. It is an invaluable reference for all those involved in personnel and vehicle protection in defence and police forces around the world. Reviews the current use of lightweight ballistic composites in both military and law-enforcement application An authoritative overview of the range of materials used, production methods and applications Explores material requirements and testing

This monograph covers all important issues of terminal ballistics in a comprehensive way combining experimental data, numerical simulations and analytical modeling. It uses a unique approach to numerical simulations as sensitivity measure for the major physical parameters. In the first chapter, the book includes necessary details about the experimental equipment which are used for ballistic tests. The second chapter covers essential features of the codes which are used in recent years all over the world, the Euler vs. Lagrange schemes, meshing techniques etc. The third chapter, devoted to the penetration mechanics of rigid rods, brings the update of modeling in this field. The fourth chapter deals with plate perforation and the fifth chapter deals with the penetration of shaped charge jets and eroding long rods. The last chapter includes several techniques for the disruption and defeating of the main threats in armor design. Throughout the book the authors demonstrate the advantages of the simulation approach in understanding the basis physics behind the investigated phenomena.

This book introduces readers to state-of-the-art theoretical and simulation techniques for determining transport in complex band structure materials and nanostructured-geometry materials, linking the techniques developed by the electronic transport community to the materials science community. Starting from the semi-classical Boltzmann Transport Equation method for complex band structure materials, then moving on to Monte Carlo and fully quantum mechanical models for nanostructured materials, the book addresses the theory and computational complexities of each method, as

well as their advantages and capabilities. Presented in language that is accessible to junior computational scientists, while including enough detail and depth with regards to numerical implementation to tackle modern research problems, it offers a valuable resource for computational scientists and postgraduate researchers whose work involves the theory and simulation of electro-thermal transport in advanced materials.

The edited volume Ballistics is a collection of reviewed and relevant research chapters, offering a comprehensive overview of recent developments in the field of engineered mechanics. The book comprises single chapters authored by various researchers and edited by an expert from the respective research area. Each chapter is complete in itself but united under a common research study topic. This publication aims to provide a thorough overview of the latest research efforts by international authors on engineered mechanics and opens new possible research paths for further novel developments.

A three-dimensional mortar interior ballistic (3D-MIB) model and code have been developed and stage-wise validated with multiple sets of experimental data in close collaboration between The Pennsylvania State Univ. (PSU) and Army Research and Development Engineering Center. This newly developed MIB model and numerical code realistically simulates the combustion and pressurization processes in various components of the 120mm mortar system. Due to the complexity of the overall interior ballistic processes in the mortar propulsion system, the overall problem has been solved in a modular fashion, i.e., simulating each component of the mortar propulsion system separately. The physical processes in the mortar system are two-phase and were simulated by considering both phases as an interpenetrating continuum. Mass and energy fluxes from the flash tube into the granular bed of M1020 ignition cartridge were determined from a semiempirical technique. For the tail-boom section, a transient one-dimensional two phase numerical code based on method of characteristics (MOC) was developed and validated by experimental test results. The mortar tube combustion processes were modeled and solved by using a two-phase Roe-Pike method with van Leer flux limiter, a fourth order Runge-Kutta scheme, and an adaptive mesh generator to account for the projectile motion. For each component, the predicted pressure-time traces showed significant pressure wave phenomena, which closely simulated the measured pressure-time traces. The experimental data for the flash tube and ignition cartridge were obtained at PSU whereas the pressure-time traces at the breech-end of the mortar tube were obtained from the tests conducted at Yuma Proving Ground (YPG). The 3D-MIB code was also used to simulate the effect of flash tube vent-hole pattern on the pressure-wave phenomenon in the ignition cartridge. A comparison of the pressure difference between primer-end and projectile-end locations of the original and mo.

Containing the proceedings of the Third International Conference on Computational Ballistics, this book presents new

ideas and advanced developments in the field of study of Computational Ballistics. Ballistic studies include applications as varied as the study of the structural and control behavior of rockets and communication satellites; bird strike effects on commercial aircraft, terrorist attacks and automobile crack worthiness modelling. Many basic problems of ballistics are similar to those in other fields of applications, such as combustion, heat conduction, in-flight structural behaviour, trajectory related issues, contact, impact, penetration, structural response to shock waves and many others.A valuable contribution to its field, this text will be of interest to researchers involved in the different areas of computational ballistics and their relationship between computational methods and experiments. Notable topics include: Systems and Technolog; Combustion and Heat Transfer; Propellants; Fluid Dynamics; Fluid Flow and Aerodynamics; In-Flight Structural Behaviour and Material Response; Guidance and Control; Perforation and Penetration Mechanics; Fluid-structure Interaction; Experimental Mechanics/ballistic and Field Testing; High Rate Loads; Composite Material; Shock and Impact.
Wound Ballistic SimulationAssessment of the Legitimacy of Law Enforcement Firearms Ammunition by Means of Wound Ballistic SimulationTheory, Methodology, Tools and Applications for Modeling and Simulation of Complex Systems16th Asia Simulation Conference and SCS Autumn Simulation Multi-Conference, AsiaSim/SCS AutumnSim 2016, Beijing, China, October 8-11, 2016, ProceedingsSpringer

The third Conference on Mathematical Models and Numerical Simulation in Electronic Industry brought together researchers in mathematics, electrical engineering and scientists working in industry. The contributions to this volume try to bridge the gap between basic and applied mathematics, research in electrical engineering and the needs of industry.
This four-volume set (CCIS 643, 644, 645, 646) constitutes the refereed proceedings of the 16th Asia Simulation Conference and the First Autumn Simulation Multi-Conference, AsiaSim / SCS AutumnSim 2016, held in Beijing, China, in October 2016. The 265 revised full papers presented were carefully reviewed and selected from 651 submissions. The papers in this second volume of the set are organized in topical sections on HMI and robot simulations; modeling and simulation for intelligent manufacturing; military simulation; visualization and virtual reality.

Advanced Fibrous Composite Materials for Ballistic Protection provides the latest information on ballistic protection, a topic that remains an important issue in modern times due to ever increasing threats coming from regional conflicts, terrorism, and anti-social behavior. The basic requirements for ballistic protection equipment are first and foremost, the prevention of a projectile from perforating, the reduction of blunt trauma to the human body caused by ballistic impact, the necessity that they are thermal and provide moisture comfort, and that they are lightweight and flexible to guarantee wearer’s mobility. The main aim of this book is to present some of the most recent developments in the design and engineering of woven fabrics and their use as layering materials to form composite structures for ballistic personal

protection. Chapter topics include High Performance Ballistic Fibres, Ultra-High Molecular Weight Polyethylene (UHMWPE), Ballistic Damage of Hybrid Composite Materials, Analysis of Ballistic Fabrics and Layered Composite Materials, and Multi-Scale Modeling of Polymeric Composite Materials for Ballistic Protection. Contributions from leading experts in the field Cutting edge developments on the engineering of ballistic materials Comprehensive analysis of the development and uses of advanced fibrous composite materials

With the proliferation of hostile theater ballistic missiles (TBMs), the Department of Defense has focused on attack operations as a means of ballistic missile defense (BMD). This thesis develops a stochastic simulation of a network for analyzing and comparing BMD strike operations. Applying knowledge of mobile launch site procedures, we construct a TBM left-of-launch network (LLN) model using discrete-event simulation software. This comprehensive network models system components from the storage phase, transportation phase, and launch phase. The simulation model integrates congestion effects after strikes are executed on the LLN. We conduct simulation experiments representing various strike combinations to quantify and compare system metrics focused on increasing the delay of TBM launches. We demonstrate BMD strike effectiveness by analyzing time-valued metrics such as the mean TBM time in system and mean time to complete launches. Increasing the delay in TBM launches grants more time for strategic decision making and prepositioning of retaliatory forces. We present this notional model and experimentation method as a guide for determining the best locations for BMD strike operations.

This book comprehensively discusses essential aspects of terminal ballistics, combining experimental data, numerical simulations and analytical modeling. Employing a unique approach to numerical simulations as a measure of sensitivity for the major physical parameters, the new edition also includes the following features: new figures to better illustrate the problems discussed; improved explanations for the equation of state of a solid and for the cavity expansion process; new data concerning the Kolsky bar test; and a discussion of analytical modeling for the hole diameter in a thin metallic plate impacted by a shaped charge jet. The section on thick concrete targets penetrated by rigid projectiles has now been expanded to include the latest findings, and two new sections have been added: one on a novel approach to the perforation of thin concrete slabs, and one on testing the failure of thin metallic plates using a hydrodynamic ram.

The objective of this study was to determine the feasibility of modeling the interior ballistic processes of the bulk-loaded liquid propellant gun. A modified version of the CRAFT Navier-Stokes code was used to perform simulations of bulk-loaded liquid propellant gun firings that employed two different chamber configurations. The simulation accurately captures the longitudinal wave structure present in the experimental data, but a combustion delay present at the start of the ballistic cycle was not present in the simulations. The simulations showed the development of a cavity that penetrated the bulk-liquid column as it accelerated

toward the projectile, leaving an annulus of unburned liquid propellant along the chamber wall. High gas temperatures were noted in this gas cavity region, possibly attributable to isentropic compression caused by the unique conditions in the bulk-loaded gun. The simulation of the second chamber configuration compared well with the experimental data, while the simulation of the first chamber configuration did not capture the experimental pressure-time profile. In general, the simulations showed an insensitivity to chamber geometry that is not observed in experimental firings. The limitations of the simulations were attributed to the lack of complete physical sub-models, such as a droplet formation/combustion model and detailed chemical kinetics. The model has the potential to be a useful tool in the analysis of experimental data. However, predictive capability is unlikely without the development of better physical sub-models.

Presents high-level research on various caliber guns, cannon, mortars, drones, warheads, shells, bullets, drills and other launchers and penetrants, as well as their impact effects on natural and designed materials, including large-scale targets and body armors Provides new modeling and test data on projectile design and guidance, propellants, charges and explosives for military, aerospace and civil engineering applicationsOver 250 presentations in two printed volumes, plus searchable CD This book makes available original ballistics technology from around the world on a wide variety of weapons and their effects, including the design and trajectory/stability control of dozens of projectiles ranging from shells to missiles. The book's authors discuss the efficacy and development of propellants, munitions, and igniters and offer new approaches for modeling and testing. Also investigated in Volume 1 are shielding and protection strategies for individual persons and other targets. Volume 2 offers research on the mechanical behavior of multiple types of explosives, as well as impact and penetration data from projectile effects on surfaces ranging from natural phenomena such as water and soils to metallic plating and material-engineered armors. Papers in these volumes were presented at a conference organized by the National Defense Industrial Association (NDIA) with the International Ballistics Society.

This book features most of the papers presented at the International Conference on Computational Ballistics 2005. The contents stress the importance and possibilities of numerical simulation on internal, external and terminal ballistics, to describe, analyse, predict and subsequently reduce the experimental requirements in ballistics.

This book is intended to help the reader understand impact phenomena as a focused application of diverse topics such as rigid body dynamics, structural dynamics, contact and continuum mechanics, shock and vibration, wave propagation and material modelling. It emphasizes the need for a proper assessment of sophisticated experimental/computational tools promoted widely in contemporary design. A unique feature of the book is its presentation of several examples and exercises to aid further understanding of the physics and mathematics of impact process from first principles, in a way that is simple to follow.

Predictive Modeling of Dynamic Processes provides an overview of hydrocode technology, applicable to a variety of industries and areas of engineering design. Covering automotive crash, blast impact, and hypervelocity impact phenomena, this volume offers readers an in-depth explanation of the fundamental code components. Chapters include informative introductions to each topic,

and explain the specific requirements pertaining to each predictive hydrocode. Successfully blending crash simulation, hydrocode technology and impact engineering, this volume fills a gap in the current competing literature available.

Academic researchers who are working on the development of composite materials for ballistic protection need a deeper understanding on the theory of material behavior during ballistic impact. Those working in industry also need to select proper composite constituents, to achieve their desired characteristics to make functional products. Composite Solutions for Ballistics covers the different aspects of ballistic protection, its different levels and the materials and structures used for this purpose. The emphasis in the book is on the application and use of composite materials for ballistic protection. The chapters provide detailed information on the various types of impact events and the complexity of materials to respond to those events. The characteristics of ballistic composites and modelling and simulation results will enable the reader to better understand impact mechanisms according to the theory of dynamic material behavior. A complete description of testing conditions is also given that includes sensors and high-speed devices to monitor ballistic events. The book includes detailed approaches and schemes that can be implemented in academic research into solutions for ballistic protection in both theoretical and experimental fields, to find solutions for existing and next generation threats. The book will be an essential reference resource for materials scientists and engineers, and academic and industrial researchers working in composite materials and textiles for ballistic protection, as well as postgraduate students on materials science, textiles and mechanical engineering courses. Discusses the fundamentals of impact response mechanisms and related solutions covering advantages and disadvantages for both existing and next generation applications Includes various methods for evaluation of ballistic constituents according to economic and environmental criteria, types of green ballistics are considered to enhance sustainable production of applications as well as hybrid composites from natural wastes Discusses selection methodologies for ballistic applications and detailed information on the use of textiles for reinforcement fabrication

HAWK Doppler radar data collected at Yuma Proving Ground, Az, for the 155mm, DPICM, M864 base-burn projectile have been reduced for the purpose of determining the aerodynamic drag. The estimated base drag reduction during base- burn motor functioning showed a very good correlation with time of flight and to a lesser degree with local atmospheric air pressure. No correlation was evident with flight Mach number, provided an effective base drag coefficient is assumed which is just a function of Mach number. This result suggests a simple addition to the Modified Point Mass Trajectory Model for the exterior ballistic simulation of the M864 base-burn projectile. Keywords: Projectile trajectories; DPICM (Dual-purpose Improved Conventional Munitions); Propelling charges; Ballistic trajectory modeling.

Original research from around the world on weapons-grade projectiles, warheads, missiles, guns and their effects on target materialsNew information on shaped charges, fire, control strategies, simulation, blast resistance, non-lethal systems and more190 original presentations in two printed volumes, plus searchable CD The first part of this 2-volume set, part of an ongoing series, presents previously unpublished research on the design and modeling of ballistic devices ranging from shells to missiles, including explosives, propellants and internal components. The second part investigates the effects of ballistic penetrants on a variety of targets, including human models, as well as hard targets and diverse armors made from engineered fibers, ceramics, metal alloys and concrete. Data is included on the modeling and testing

of novel devices, explosives and shielding strategies. Papers in this text were presented at a symposium organized by the National Defense Industrial Association with the International Ballistics Society. The CD-ROM displays figures and illustrations in articles in full color along with a title screen and main menu screen. Each user can link to all papers from the Table of Contents and Author Index and also link to papers and front matter by using the global bookmarks which allow navigation of the entire CD-ROM from every article. Search features on the CD-ROM can be by full text including all key words, article title, author name, and session title. The CD-ROM has Autorun feature for Windows 2000 with Service Pack 4 or higher products along with the program for Adobe Acrobat Reader with Search 11.0. One year of technical support is included with your purchase of this product.

Includes papers that were first presented at a September 2011 conference organized by the National Defense Industrial Association and the International Ballistics Society. This title includes a CD-ROM that displays figures and illustrations in articles in full color along with a title screen and main menu screen.

Numerical simulation of terminal ballistic events requires quantitative modeling of the complex material responses which are observed to occur experimentally. This report discusses current deficiencies and future needs for material modeling in this context and suggests some specific efforts which, in the opinion of the authors, could substantially improve the utility of simulation as a design and analysis tool for armor/anti-armor systems. terminal ballistics, armor, anti-armor ammunition, numerical methods, material modeling.

The overarching theme of the work originally proposed concerned the development of three-dimensional computational capability enabling the lagrangian simulation of armor penetration. The principal objectives of the work, as stated in the proposal, were: (1) The development of three-dimensional computational capability including adaptive meshing, direct simulation of fracture and fragmentation by cohesive elements, nonsmooth contact and friction. (2) Verification and validation of the unit algorithms. (3) The demonstration of the predictive ability of the integrated facility in problems of ballistic penetration of interest to the Army. All the unit algorithms required to carry out the simulations of interest in three dimensions have been developed and successfully tested. The degree of difficulty involved in the development of these algorithms vanes from low (e.g., the extension of the constitutive updates to three dimensions) to exceptional high (most notably, the development of automatic 3D meshing capability for arbitrary domains). Some of the main accomplishments are summarized next.

The scaling of MOSFETs as dictated by the ITRS has continued unabated for many years and enabled the worldwide semiconductor market to grow at a phenomenal rate. However, the ITRS scaling is reaching hard limitations. One of the most significant problems is the maintenance of electrostatic integrity, which demands the use of extremely thin gate oxides to provide the required high gate capacitance, as well as the use of high channel doping to control short channel effects. These requirements lead to low device performance and tunneling current becomes quite prominent. This book introduces a promising solution to these problems, that is Double Gate MOSFET with high-k gate stack. This book provides an elaborate performance analysis of DG MOSFET with high-k material on both top and bottom gate stack in terms of drain current & subthreshold characteristics using 2D quantum simulator nanoMOS 4.0.

Reviews our current understanding of the subject. For graduate students and researchers in computational fluid dynamics and turbulence.

"This thesis presents models, simulation techniques, and simulation results for two types of semiconductor nanodevice; the metal-semiconductor-metal (MSM) photodetector, and the ballistic deflection transistor (BDT). Our simulation tools were developed using

the commercial Comsol[trademark symbol] finite element analysis (FEA) field solver to obtain the numeric solutions. Finite element models have been developed for both an alloyed- and surface-contact MSM photodetector. The simulation results agree with previously reported experimental data. The alloyed device, despite having a somewhat larger capacitance, has a non-illuminated region of lower resistance with a more-uniform and deeper-penetrating electric field and carrier transport current. The latter explains, in terms of the equivalent lumped parameters, the experimentally observed faster response of such device. The model was further used to predict improved responsivity, based on electrode spacing and antireflective coating, as well as the optimal depth of the alloyed contact being approximately half of the optical penetration depth. For the BDT, novel simulation techniques, also based on the FEA method, have been developed. The results demonstrate that diffusive transport is capable of predicting the current vs. voltage characteristics of the current-generation of BDTs, as well as the effects of selected changes in the BDT geometry. Simulation results were used to predict the characteristics of several variations of scaled-down and geometry-modified devices and other physical parameters. Also, the newly introduced concept of ballistic conductivity predicts behavior consistent with ballistic transport, relative to the effect of the deflector, for small devices."--Leaves vii-viii.

A small-scale apparatus for simulating the motion and heating of ballistic missiles is described along with elements of design and operation. Experiments with the apparatus demonstrate that conditions for simulation are fulfilled according to the theoretical requirements.

This book combines semi-physical simulation technology with an Internet of Things (IOT) application system based on novel mathematical methods such as the Fisher matrix, artificial neural networks, thermodynamic analysis, support vector machines, and image processing algorithms. The dynamic testing and semi-physical verification of the theory and application were conducted for typical IOT systems such as RFID systems, Internet of Vehicles systems, and two-dimensional barcode recognition systems. The findings presented are of great scientific significance and have wide application potential for solving bottlenecks in the development of RFID technology and IOT engineering. The book is a valuable resource for postgraduate students in fields such as computer science and technology, control science and engineering, and information science. Moreover, it is a useful reference resource for researchers in IOT and RFID-related industries, logistics practitioners, and system integrators.