

Yasuyuki Horie Lee Davison  
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Editors

# High-Pressure Shock Compression of Solids VI

Old Paradigms and  
New Challenges



Springer

# High Pressure Shock Compression Of Solids Vi

**Suhithi M. Peiris, Gasper J. Piermarini**



## **High Pressure Shock Compression Of Solids VI:**

**High-Pressure Shock Compression of Solids VI** Yasuyuki Horie, Lee Davison, Naresh Thadani, 2012-12-06 Both experimental and theoretical investigations make it clear that mesoscale materials that is materials at scales intermediate between atomic and bulk matter do not always behave in ways predicted by conventional theories of shock compression At these scales shock waves interact with local material properties and microstructure to produce a hierarchy of dissipative structures such as inelastic deformation fields randomly distributed lattice defects and residual stresses A macroscopically steady planar shock wave is neither plane nor steady at the mesoscale The chapters in this book examine the assumptions underlying our understanding of shock phenomena and present new measurements calculations and theories that challenge these assumptions They address such questions as What are the experimental data on mesoscale effects of shocks and what are the implications Can one formulate new mesoscale theories of shock dynamics How would new mesoscale theories affect our understanding of shock induced phase transitions or fracture What new computational models will be needed for investigating mesoscale shocks

**High-Pressure Shock Compression of Solids VI** Yasuyuki Horie, Lee W. Davison, Naresh N. Thadani, 2003 Both experimental and theoretical investigations make it clear that mesoscale materials that is materials at scales intermediate between atomic and bulk matter do not always behave in ways predicted by conventional theories of shock compression At these scales shock waves interact with local material properties and microstructure to produce a hierarchy of dissipative structures such as inelastic deformation fields randomly distributed lattice defects and residual stresses A macroscopically steady planar shock wave is neither plane nor steady at the mesoscale The chapters in this book examine the assumptions underlying our understanding of shock phenomena and present new measurements calculations and theories that challenge these assumptions They address such questions as What are the experimental data on mesoscale effects of shocks and what are the implications Can one formulate new mesoscale theories of shock dynamics How would new mesoscale theories affect our understanding of shock induced phase transitions or fracture And what new computational models will be needed for investigating mesoscale shocks

**Shock-Wave Phenomena and the Properties of Condensed Matter** Gennady I. Kanel, Sergey V. Razorenov, Vladimir E. Fortov, 2013-06-29 One of the main goals of investigations of shock wave phenomena in condensed matter is to develop methods for predicting effects of explosions high velocity collisions and other kinds of intense dynamic loading of materials and structures Based on the results of international research conducted over the past 30 years this book is addressed not only to experts in shock wave physics but also to interested representatives from adjacent fields of activity and to students who seek an introduction to the current issues With that goal in mind the book opens with a brief account of the theoretical background and a short description of experimental techniques The authors then progress to a systematic treatment of special topics some of which have not been fully addressed in the literature to date

**Shock Phenomena in Granular and Porous Materials** Tracy J. Vogler, D.

Anthony Fredenburg, 2019-09-04 Granular forms of common materials such as metals and ceramics sands and soils porous energetic materials explosives reactive mixtures and foams exhibit interesting behaviors due to their heterogeneity and critical length scale typically commensurate with the grain or pore size Under extreme conditions of impact granular and porous materials display highly localized phenomena such as fracture inelastic deformation and the closure of voids which in turn strongly influence the bulk response Due to the complex nature of these interactions and the short time scales involved computational methods have proven to be powerful tools to investigate these phenomena Thus the coupled use of experiment theory and simulation is critical to advancing our understanding of shock processes in initially porous and granular materials This is a comprehensive volume on granular and porous materials for researchers working in the area of shock and impact physics The book is divided into three sections where the first presents the fundamentals of shock physics as it pertains to the equation of state compaction and strength properties of porous materials Building on these fundamentals the next section examines several applications where dynamic processes involving initially porous materials are prevalent focusing on the areas of penetration planetary impact and reactive munitions The final section provides a look at emerging areas in the field where the expansion of experimental and computational capabilities are opening the door for new opportunities in the areas of advanced light sources molecular dynamics modeling and additively manufactured porous structures By intermixing experiment theory and simulation throughout this book serves as an excellent up to date desk reference for those in the field of shock compression science of porous and granular materials

#### **High-pressure Shock Compression of Solids J. R.**

Asay, Mohsen Shahinpoor, 1993 This book presents a set of basic understandings of the behavior and response of solids to propagating shock waves The propagation of shock waves in a solid body is accompanied by large compressions decompression and shear Thus the shear strength of solids and any inelastic response due to shock wave propagation is of the utmost importance Furthermore shock compression of solids is always accompanied by heating and the rise of local temperature which may be due to both compression and dissipation For many solids under a certain range of impact pressures a two wave structure arises such that the first wave called the elastic precursor travels with the speed of sound and the second wave called a plastic shock wave travels at a slower speed Shock wave loading of solids is normally accomplished by either projectile impact such as produced by guns or by explosives The shock heating and compression of solids covers a wide range of temperatures and densities For example the temperature may be as high as a few electron volts 1 eV 11 500 K for very strong shocks and the densification may be as high as four times the normal density

Thermo-Gas Dynamics of Hydrogen Combustion and Explosion Boris E. Gelfand, Mikhail V. Silnikov, Sergey P. Medvedev, Sergey V.

Khomik, 2012-02-13 The potential of hydrogen as an important future energy source has generated fresh interest in the study of hydrogenous gas mixtures Indeed both its high calorificity and reactivity are unique properties the latter underscoring safety considerations when handling such mixtures The present monograph is devoted to the various aspects of hydrogen

combustion and explosion processes In addition to theoretical and phenomenological considerations this work also collates the results of many experiments from less well known sources The text reviews the literature in this respect thereby providing valuable information about the thermo gas dynamical parameters of combustion processes for selected experimental settings in a range of scientific and industrial applications

Shock Wave Reflection Phenomena Gabi Ben-Dor, 2007-08-28 This book is a comprehensive state of the knowledge summation of shock wave reflection phenomena from a phenomenological point of view It includes a thorough introduction to oblique shock wave reflections dealing with both regular and Mach types It also covers in detail the corresponding two and three shock theories The book moves on to describe reflection phenomena in a variety of flow types as well as providing the resolution of the Neumann paradox

*High-Energy-Density Physics* R. Paul Drake, 2006-08-31 This book has two goals One goal is to provide a means for those new to high energy density physics to gain a broad foundation from one text The second goal is to provide a useful working reference for those in the field This book has at least four possible applications in an academic context It can be used for training in high energy density physics in support of the growing number of university and laboratory research groups working in this area It also can be used by schools with an emphasis on ultrafast lasers to provide some introduction to issues present in all laser target experiments with high power lasers and with thorough coverage of the material in Chap 11 on relativistic systems In addition it could be used by physics applied physics or engineering departments to provide in a single course an introduction to the basics of fluid mechanics and radiative transfer with dynamic applications Finally it could be used by astrophysics departments for a similar purpose with the benefit of training the students in the similarities and differences between laboratory and astrophysical systems The notation in this text is deliberately sparse and when possible a given symbol has only one meaning A definition of the symbols used is given in Appendix A In various cases additional subscripts are added to distinguish among cases of the same quantity as for example in the use of  $\rho_1$  and  $\rho_2$  to distinguish the mass density in two different regions

**Material Properties under Intensive Dynamic Loading** Mikhail V.

Zhernokletov, B. L. Glushak, 2007-07-16 Understanding the physical and thermomechanical response of materials subjected to intensive dynamic loading is a challenge of great significance in engineering today This volume assumes the task of gathering both experimental and diagnostic methods in one place since not much information has been previously disseminated in the scientific literature

*Static Compression of Energetic Materials* Suhithi M. Peiris, Gasper J. Piermarini, 2009-01-03

Developing and testing novel energetic materials is an expanding branch of the materials sciences Reaction detonation or explosion of such materials invariably produce extremely high pressures and temperatures To study the equations of state EOS of energetic materials in extreme regimes both shock and static high pressure studies are required The present volume is an introduction and review of theoretical experimental and numerical aspects of static compression of such materials Chapter 1 introduces the basic experimental tool the diamond anvil pressure cell and the observational techniques used with

it such as optical microscopy infrared spectrometry and x ray diffraction Chapter 2 outlines the principles of high nitrogen energetic materials synthesis Chapters 3 and 4 examine and compare various EOS formalisms and data fitting for crystalline and non crystalline materials respectively Chapter 5 details the reaction kinetics of detonating energetic materials Chapter 6 investigates the interplay between static and dynamic shock studies Finally Chapters 7 and 8 introduce numerical simulations molecular dynamics of energetic materials under either hydrostatic or uni axial stress and ab initio treatments of defects in crystalline materials This timely volume meets the growing demand for a state of the art introduction and review of the most relevant aspects of static compression of energetic materials and will be a valuable reference to researchers and scientists working in academic industrial and governmental research laboratories

**Mathematical Modeling of Shock-Wave Processes in Condensed Matter** Tatiana Aleksandrovna Khantuleva, 2022-07-18 This book offers an interdisciplinary theoretical approach based on non equilibrium statistical thermodynamics and control theory for mathematically modeling shock induced out of equilibrium processes in condensed matter The book comprises two parts The first half of the book establishes the theoretical approach reviewing fundamentals of non equilibrium statistical thermodynamics and control theory of adaptive systems The latter half applies the presented approach to a problem on shock induced plane wave propagation in condensed matter The result successfully reproduces the observed feature of waveform propagation in experiments which conventional continuous mechanics cannot access Further the consequent stress strain relationships derived with relaxation and inertia effect in elastic plastic transition determines material properties in transient regimes

*Shock Fitting* Marcello Onofri, Renato Paciorri, 2017-11-18 This book describes the revolutionary capabilities of new shock fitting algorithms a great improvement in computational fluid dynamics CFD for high speed numerical simulations Shock fitting methods provide a solution to the current difficulties and inaccuracies in shock capturing approaches This work traces the evolution of shock fitting methods from the pioneering methods based on the structured grids boundary and floating shock fitting to recent developments on unstructured grids illustrating algorithmic details significant applications and potential developments Also to celebrate the centenary birth of the father of shock fitting techniques the book also includes a tribute to Gino Moretti as well as his unpublished manuscript This book will appeal to professionals researchers and graduate students in the field of CFD

**Hydrodynamics of Explosion** Valery K. Kedrinskiy, 2005-11-04 Hydrodynamics of Explosion presents the research results for the problems of underwater explosions and contains a detailed analysis of the structure and the parameters of the wave fields generated by explosions of cord and spiral charges a description of the formation mechanisms for a wide range of cumulative flows at underwater explosions near the free surface and the relevant mathematical models Shock wave transformation in bubbly liquids shock wave amplification due to collision and focusing and the formation of bubble detonation waves in reactive bubbly liquids are studied in detail Particular emphasis is placed on the investigation of wave processes in cavitating liquids which incorporates the concepts of the strength of real liquids

containing natural microinhomogeneities the relaxation of tensile stress and the cavitation fracture of a liquid as the inversion of its two phase state under impulsive explosive loading The problems are classed among essentially nonlinear processes that occur under shock loading of liquids and may be of interest to researchers in physical acoustics mechanics of multiphase media shock wave processes in condensed media explosive hydroacoustics and cumulation

*Introduction to Simple Shock Waves in Air* Seán Prunty, 2018-12-13 This book provides an elementary introduction to some one dimensional fluid flow problems involving shock waves in air The differential equations of fluid flow are approximated by finite difference equations and these in turn are numerically integrated in a stepwise manner Artificial viscosity is introduced into the numerical calculations in order to deal with shocks The presentation is restricted to the finite difference approach to solve the coupled differential equations of fluid flow as distinct from finite volume or finite element methods This text presents the results arising from the numerical solution using Mathcad programming Both plane and spherical shock waves are discussed with particular emphasis on very strong explosive shocks in air This text will appeal to students researchers and professionals in shock wave research and related fields Students in particular will appreciate the benefits of numerical methods in fluid mechanics and the level of presentation

**High-Pressure Shock Compression of Solids** J.R. Asay, M. Shahinpoor, 2012-12-06 This book presents a set of basic understandings of the behavior and response of solids to propagating shock waves The propagation of shock waves in a solid body is accompanied by large compressions decompression and shear Thus the shear strength of solids and any inelastic response due to shock wave propagation is of the utmost importance Furthermore shock compression of solids is always accompanied by heating and the rise of local temperature which may be due to both compression and dissipation For many solids under a certain range of impact pressures a two wave structure arises such that the first wave called the elastic precursor travels with the speed of sound and the second wave called a plastic shock wave travels at a slower speed Shock wave loading of solids is normally accomplished by either projectile impact such as produced by guns or by explosives The shock heating and compression of solids covers a wide range of temperatures and densities For example the temperature may be as high as a few electron volts 1 eV 11 500 K for very strong shocks and the densification may be as high as four times the normal density

**Detonation Control for Propulsion** Jiun-Ming Li, Chiang Juay Teo, Boo Cheong Khoo, Jian-Ping Wang, Cheng Wang, 2017-12-05 This book focuses on the latest developments in detonation engines for aerospace propulsion with a focus on the rotating detonation engine RDE State of the art research contributions are collected from international leading researchers devoted to the pursuit of controllable detonations for practical detonation propulsion A system level design of novel detonation engines performance analysis and advanced experimental and numerical methods are covered In addition the world's first successful sled demonstration of a rocket rotating detonation engine system and innovations in the development of a kilohertz pulse detonation engine PDE system are reported Readers will obtain in a straightforward manner an understanding of the RDE

PDE design operation and testing approaches and further specific integration schemes for diverse applications such as rockets for space propulsion and turbojet ramjet engines for air breathing propulsion Detonation Control for Propulsion Pulse Detonation and Rotating Detonation Engines provides with its comprehensive coverage from fundamental detonation science to practical research engineering techniques a wealth of information for scientists in the field of combustion and propulsion The volume can also serve as a reference text for faculty and graduate students and interested in shock waves combustion and propulsion

**High-Pressure Chemistry and Physics of Polymers** A.L. Kovarskii,1994-02-03 High Pressure Chemistry and Physics of Polymers is devoted to covering all areas of high pressure polymer materials science Topics addressed include the synthesis of polymers changes in reactivity structural transformations molecular dynamics relaxation processes deformational properties chemical modification and the effect of shock waves and shear stresses The authors contributions reflect over 60 years of Soviet study in the field of physico chemistry conducted at the major former Soviet Institutes of Chemical Physics Organic Chemistry Polymer Chemistry and Physical Chemistry Fundamental topics such as compressibility of polymers polymerization under pressure viscoelastic deformational properties and polymer modification are discussed with an eye toward materials development for improving physical models and methods of calculating the changing parameters of materials under pressure The book is a valuable reference to data on mechanisms of physical and chemical processes in addition to new experimental data for improving physical models and methods of calculating changes in material characteristics under compression loads High Pressure Chemistry and Physics of Polymers will be an important reference for graduate students and practicing professionals in polymer chemistry and polymeric materials

**Explosive Effects and Applications** Jonas A. Zukas,William Walters,2013-12-01 This is a broad based text on the fundamentals of explosive behavior and the application of explosives in civil engineering industrial processes aerospace applications and military uses

**Materials in Mechanical Extremes** Neil Bourne,2013-05-09 This book explores the underlying principles of materials under extreme pressures providing a toolbox for assessing predicting their behaviour in real world applications

**Medical and Biomedical Applications of Shock Waves** Achim M. Loske,2016-12-01 This book provides current comprehensive and clear explanations of the physics behind medical and biomedical applications of shock waves Extracorporeal shock wave lithotripsy is one of the greatest medical advances of our time and its techniques and clinical devices are continuously evolving Further research continues to improve the understanding of calculi fragmentation and tissue damaging mechanisms Shock waves are also used in orthopedics and traumatology Possible applications in oncology cardiology dentistry gene therapy cell transfection transformation of fungi and bacteria as well as the inactivation of microorganisms are promising approaches for clinical treatment industrial applications and research Medical and Biomedical Applications of Shock Waves is useful as a guide for students technicians and researchers working in universities and laboratories Chemists biologists physicians and veterinarians involved in research or clinical practice will find useful advice



but also engineers and physicists may benefit from the overview of current research endeavors and future directions  
Furthermore it may also serve to direct manufacturers towards the design of more efficient and safer clinical industrial and laboratory equipment

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In a global inundated with monitors and the cacophony of fast connection, the profound energy and emotional resonance of verbal art frequently fade in to obscurity, eclipsed by the regular onslaught of sound and distractions. Yet, nestled within the musical pages of **High Pressure Shock Compression Of Solids Vi**, a interesting function of fictional splendor that impulses with organic thoughts, lies an remarkable journey waiting to be embarked upon. Composed with a virtuoso wordsmith, this exciting opus manuals viewers on a psychological odyssey, gently exposing the latent potential and profound impact stuck within the complicated internet of language. Within the heart-wrenching expanse of this evocative examination, we can embark upon an introspective exploration of the book is main themes, dissect its fascinating writing model, and immerse ourselves in the indelible impact it leaves upon the depths of readers souls.

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