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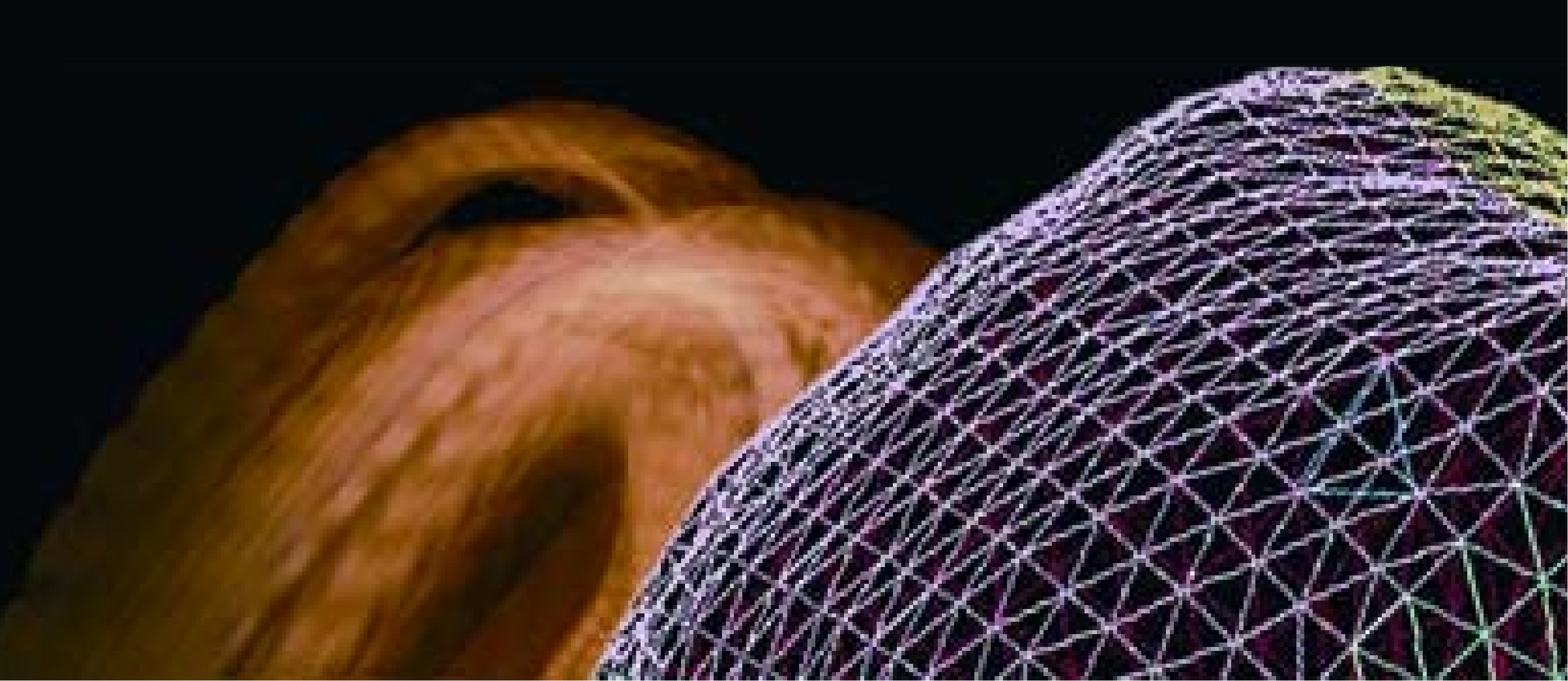
MULTIPHYSICS 2017

14 - 15 December 2017
Beijing, China



MULTIPHYSICS 2017

14-15 December 2017
Beijing, China

Conference Board

General Information

Scope of Conference

Understanding real physics and performing Multiphysics simulation are extremely important to analyse complex systems in order to better design and manufacture engineering products.

The objective of the conference is to share and explore findings on mathematical advances, numerical modelling and experimental validation of theoretical and practical systems in a wide range of applications.

The scope of the conference is to address the latest advances in theoretical developments, numerical modelling and industrial application, which will promote the concept of simultaneous engineering. Typical combinations would involve a selection from subject disciplines such as Acoustics, Electrics, Explosives, Fire, Fluids, Magnetic, Nuclear, Soil, Structures, and Thermodynamics.

Registration Pack – Collection Hours

Registration packs should be collected from the Registration Desk. Collection Hours are as follows:

Thursday, 14th December	9:00-17:30
Friday, 15th December	9:00-17:30

Special Events

Thursday, 14th December Group Photograph	11:00
Thursday, 14th December Conference Banquet	19:30

Timing of Presentations

Each paper will be allocated 20 minutes. A good guide is 15 minutes for presentation with 5 minutes left for questions at the end.

Good timekeeping is essential, speakers are asked to keep strictly to 20 minutes per presentation.

Group Photograph

A group photograph will be taken during the tea/coffee break on the first day of the Conference.

Language

The official language of the conference is English.

Audio-visual

The lecture room will be equipped with the following: One laptop, one LCD projection and cables, one screen, and one microphone.

Delegates are requested to bring presentations on a memory stick.

Paper Publication

Authors are invited to submit full-length papers for publication in 'The International Journal of Multiphysics' by 31st January 2018.

There is no Article Processing Charge (APC) for one article per registration.

Sponsorship

The Conference Board would like to thank the sponsors for their support.

Keynote Speaker

Thurai Rahulan
BSc (Hons), PhD, AMIMechE, FRAeS
University of Salford
United Kingdom

BIOGRAPHY

Thurai Rahulan was born in Sri Lanka in 1958 and graduated with First Class Honours in Mechanical Engineering Science in 1979 before being awarded the degree of PhD by Salford University in the United Kingdom in 1984. He commenced full time employment in 1983 designing aircraft active control systems on research programmes funded by the British Ministry of Defence. He then spent a few years working on suspension systems at Jaguar Cars Limited in Coventry, England after which he returned to Salford University in 1990 to teach aeronautics.

Dr Rahulan has published and refereed many scientific papers in international journals. In addition to liaising with many universities and the industry, he serves on the Council and the Board of Trustees of the Royal Aeronautical Society. He is the Chairman of the Association of Aerospace Universities and the Secretary of the International Society of Multiphysics. Furthermore, he also serves on the executive committees of the Institution of Mechanical Engineers Aerospace North West and the Engineering Professors' Council in the United Kingdom.

MULTIPHYSICS 2017

PROGRAMME

TIME	Thursday 14 December 2017	Friday 15 December 2017
09:00 - 09:30	**Registration**	
09:30 - 11:00	**Keynote Address & Synopsis**	**Session 2.1** *Impact and Explosions*
11:00 - 11:30	**Tea/Coffee Break**	
11:30 - 13:00	**Session 1.2** *Industrial Applications*	**Session 2.2** *Composite Modelling*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Advanced Simulation Techniques*	**Session 2.3** *Micromechanics and Materials*
15:30 - 16:00	**Tea/Coffee Break**	
16:00 - 17:30	**Session 1.4** *Posters*	**Session 2.4** *Developments in Multiphysics*
19:30	**Banquet**	

Full Programme

Thursday 14 December 2017

09:00 – 09:30 Registration

09:30 – 09:45 Conference Opening

Opening of The 12th International Conference of Multiphysics 2017
Dean P. Chen, Beijing Institute of Technology, China

09:45 – 11:00 Session 1.1
Keynote Address & Synopsis

Chair: M Moatamedi, The International Society of Multiphysics

Keynote Address: Design Evolution of Large Airliners

Thurai Rahulan, Senior Lecturer in Aeronautics, University of Salford, United Kingdom

Synopsis Part 1: The International Journal of Multiphysics

Hassan Khawaja, Editorial Manager of The International Journal of Multiphysics

Synopsis Part 2: The International Conference of Multiphysics 2018

Jakub Roemer, AGH University of Science and Technology, Poland

11:00-11:30 Tea/Coffee Break & Group Photograph

Thursday 14 December 2017

11:30-13:00 Session 1.2
Industrial Applications

Chair: P Chen, Beijing Institute of Technology, China

Invited Speaker: Trends in Advanced Manufacturing

Athanasios G. Mamalis
Project Center for Nanotechnology and Advanced Engineering, NCSR "Demokritos". Greece

Experiments and Simulations on loads of Close-Proximity Underwater Explosion

Fengjiang An, Xu Li, Jinhe Li, Cheng Wu
School of Mechatronical Engineering, Beijing Institute of Technology, China

Experimental study on the Gas Foil Bearings air cooling based thermal management method

Jakub Roemer, Michal Lubieniecki, Adam Martowicz
AGH University of Science and Technology, Poland

Analysis of stresses and surface topology of dynamically agitated fluids

Daniel Brunner[(a)], Mirjam Clemens[(b)], Fabian Sager[(b)], Heike Cremer[(b)], Gernot Boiger[(a)]
a: ICP Institute of Computational Physics, School of Engineering, Zurich University of Applied Sciences
b: F. Hoffmann-La Roche Ltd

13:00-14:00 Lunch

Thursday 14 December 2017

14:00-15:30 **Session 1.3**
Advanced Simulation Techniques

Chair: B Alzahabi, Al Ghurair University, UAE

Invited Speaker: Dual-Horizon Peridynamics

Timon Rabczuk[a], Huilong Ren[a], Xiaoying Zhuang[b]
a. Bauhaus University Weimar, Institute of Structural Mechanics, Germany
b. University of Hannover, Institute of Continuum Mechanics, Hannover, Germany

Ozone layer Thickness Calculations Based on Atmospheric Radiative Transfer Modelling: A case study of radiation measurements from Tromsø, Norway (69.7 N, 18.9E)

Kåre Edvardsen
UiT-The Arctic University of Norway, Tromsø, Norway

Numerical simulation for soil surface explosion problem by SPH method

Yoshikazu HIGA[a], Hirofumi IYAMA[b], Ken SHIMOJIMA[a], Osamu HIGA[c] and Shigeru ITOH[d]
a. Dept. Mech. Sys. Eng., Nat. Inst. Tech., Okinawa College
b. Dept. Mech. Intel. Sys. Eng., Nat. Inst. Tech., Kumamoto College
c. Sci. Tech. Div., Nat. Inst. Tech., Okinawa College
d. Emeritus Prof., Kumamoto Univ. & Nat. Inst. Tech., Okinawa College, Japan

Dynamic modeling of ionized oxygen distribution within powder coating pistols

Gernot Boiger
Zurich University of Applied Sciences, Switzerland

15:30-16:00 **Tea / Coffee Break**

Thursday 14 December 2017

16:00-17:30 Session 1.4
Posters

Numerical simulation led design of the planar shock recovery assembly

Tan Zhen, Chen Pengwan, Zhou Qiang
Beijing Institute of Technology, China

Behavior of Bubble Jetting and Loading on Air-backed Plate Subjected to Near-Field Underwater Explosion: Experiments and Simulations

Fengjiang An, Lihui Dai, Dongyu Xue, Yuxia Zhang
School of Mechatronical Engineering, Beijing Institute of Technology, China

Development of shock wave generating device using high-voltage pulsed discharge

Kazuki Tokeshi, Osamu Higa, Shoichi Tanifuji, Shigeru Itoh
National Institute of Technology, Okinawa College, Japan

Numerical Simulation on Structure Effects of Gas Explosions in Vessels

Chen Yan, Zhirong Wang, Chi Ma, Weidong Ma
College of Safety Science and Engineering, Nanjing Tech University, China

Comparison of Cell Transferability in Shockwave Molded Replica Specimen

A.Takemoto[a], S. Tanaka[b], O. Higa[a], A. Mori[c], K. Hokamoto[b], S. Itoh[a,b]
a. National Institute of Technology, Okinawa College, Nago, Okinawa, Japan
b. Kumamoto University, Japan
c. Sojo University, Japan

Development of food processing equipment using underwater shock wave

Yudai Uezato, Ken Shimojima, Osamu Higa, Shigeru Itoh
National Institute of Technology, Okinawa College, Japan

Shock-induced phase transition of iron studied with phase field method

Guo Xianghua, Wang Zhaolong
School of Mechatronical Engineering, Beijing Institute of Technology, China

FSI of viscosity measuring mechanical resonators: theoretical and experimental analysis

Daniel Brunner[(a)], Klaus Häusler[(b)], Sunil Kumar[(b)], Gernot Boiger[(a)], Hassan Abbas Khawaja[(c)], Moji Moatamedi[(c)]

a. Zurich University of Applied Sciences, Switzerland

b. Rheonics GMBH, Switzerland

c. UiT-The Arctic University of Norway

Fluorescent Marking of Roads in High-North

H. Khawaja, B. Varughese, K. Edvardsen

UiT-The Arctic University of Norway

Detection of Cracks and Potholes in Roads using Infrared Thermography

T. Ahmad, H. Khawaja

UiT The Arctic University of Norway

Modelling and Simulation of the HDPE Pyrolysis Process

H. Eidesen, H. Khawaja, S Jackson

UiT The Arctic University of Norway

Detection, Identification and size distribution of micro-plastic particles

Bindu Sara Varughese, Kåre Edvardsen

UiT The Arctic University of Norway, Norway

An FEM-based AI approach to parameter identification for low vibration modes of HAWT composite rotor blades

N. Navadeh[(b)], I.O. Gorshko[(b)], Y.A. Zhuk[(b)], A.S. Fallah[(c)]

a. Imperial College London)

b. Taras Shevchenko

c. Brunel University London

SPH simulation of annular jet formation and penetration associated with underwater explosion

Zhifan Zhang, Cheng Wang

State Key Lab of Explosion Science and Technology, Beijing Institute of Technology, China

Study of Grooved Warhead Structure on Performance of Warhead Fragment Distribution Pattern

JING Qingbo

Xi'an Modern Chemistry Research Institute, China

An Improved Gurney Model to Predict Initial Velocity of Parallel-moving Rod-shaped Fragments

Xue Biao, Jing Qingbo

Xi'an Modern Chemistry Research Institute, China

Dynamic Response of a Double Cylindrical Shell under Internal Explosive Loading

Cai Ze, Long Renrong

State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

The response characteristics of warhead fragment impact on shielded H6 explosive

Jun Peng, Baohui Yuan, Xingyun Sun, Qingbo Jing

Xi'an Modern Chemistry Research Institute, China

Simulation and Evaluation of Damage Effect of Ring Damage Unit to Kinetic Energy Interceptor

Shengao Wang, Maohua Du, Dengjian Fang

Naval University of Aeronautics, Naval University of Engineering, China

Effects of Crystal Morphology on Impact Sensitivity of LLM-105 Based Explosives

Yanqing Wu

State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Laser ignition and combustion mechanisms of magnesium single particles

Lu Sun, Shi Yan, Yachen Wu, Jinggu Cao，Jinlong Zhang

State Key Laboratory of Explosive Science and Technology, Beijing Institute of Technology, China

Mechanical and ignition of PBX explosives based on micro-cracking model

Yanqing Wu

State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Optimisation and application of Hall effect Sensor

Houaria Bourbaba, Kadri Syham

LPDS laboratory, Bechar University Algeria, Algeria

Large scale and high precision numerical simulation of explosion problem on the Sunway supercomputer platform

Haitao Zhao[a], Cheng Wang[b]

a. Laboratory of Parallel Software & Computational Science, Institute of Software, Chinese Academy of Sciences, Beijing, China

b. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

19:30 Conference Banquet

Friday 15 December 2017

09:30-11:00 Session 2.1
Impact and Explosions

Chair: T Rahulan, University of Salford, United Kingdom

Invited Speaker: Advancement in Numerical Simulation Investigation on Explosion and Impact Problems

Cheng Wang
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Effects of Micro-bubble on Underwater Shock Wave Generation using Spark Discharge

Osamu Higa, Kazuki Tokeshi, Shoichi Tanifuji, Shigeru Itoh
National Institute of Technology, Okinawa college, Japan

CFD Simulation on Study of Structural Effects of a Methane-Air Mixtures Explosion in Linked Vessels

Yaya Zhen, Zhirong Wang, Chen Yan, Fei Jiao
Jiangsu Key Laboratory of Urban and Industrial Safety, College of Safety Science and Engineering, Nanjing Tech University, China

Computational simulation and production of pressure vessels for food processing Using Uderwater Shockwave

Ken Shimojima, Osamu Higa, Yoshikazu Higa, Shigeru Itoh
Okinawa College, Japan

11:00-11:30 Tea / Coffee Break

Friday 15 December 2017

11:30 – 13:00 Session 2.2 Composite Modelling

Chair: G Boiger, ZHAW, Switzerland

Invited Speaker: Impact Testing and Modelling an E-Glass Fiber Reinforced Polymer Composite

Mustafa Güden, Kutlay Odacı, Alper Tasdemirci

Dynamic Testing and Modelling Laboratory, Mechanical engineering Department, İzmir Institute of Technology, Urla, Turkey

Numerical Simulation on Discarding Sabot of Hyper-velocity Projectile Perforating Laminated Pine Wood Target

Chu Yunlin[(a)], Shen Chao[(b)], LIU Liu[(c)], Wu Wenyou[(a)],PI Aiguo[(a)],

a. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

b. Beijing HIWING Science and Technology Information Institute

c. Southern Sichuan Machinery

State-of-the-art techniques in crack detection and utilizing innovative materials for the repair and maintenance of roads

H Khawaja,
UiT The Arctic University of Norway, Tromsø, Norway

Dynamic Mechanical Property Study of a typical CFRP Laminate Under High Impact Compressive Loads

WU Wenyou[(a)], LIU Liu[(b)], CHU Yunlin[(a)], PI Aiguo[(a)],

a. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing 100081, China

b. Southern Sichuan Machinery

13:00-14:00 Lunch

Friday 15 December 2017

14:00-15:30 Session 2.3
Micromechanics and Materials

Chair: H Khawaja, UiT-The Arctic University of Norway

Invited Speaker: Synthesis and Densification of Heterogeneous Ultrafine and Nanostructured Materials by High Rate Energy Processes: Materials and Devices

Fernand D S Marquis
Department of Mechanical Engineering, San Diego State University, USA

Wider strain-rate dependent damage constitutive model for PBX explosive and its application in penetrating concrete target simulations

Yanqing Wu
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Microjetting from a grooved Pb surface under supported and unsupported shock conditions

Jian-Li Shao[(a)], Pei Wang[(b)], Cheng Wang[(a)]
a. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China
b. Institute of Applied Physics and Computational Mathematics, Beijing 100094, China

High-rate squeezing process of bulk metallic glasses

Jitang Fan
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

15:30-16:00 Tea / Coffee Break

Friday 15 December 2017

16:00-17:00 Session 2.4
Development in Multiphysics

Chair: C Wang, Beijing Institute of Technology, China

Effects of Heat Loss at Walls on Flame Acceleration and Deflagration-to-Detonation Transition

Han Wenhu
Key Laboratory of Light-Duty Gas-Turbine, Institute of Engineering Thermophysics, Chinese Academy of Sciences, China

Investigation on Multi-Medium Flows and Explosions by Finite Difference Moment of Fluid Method

Hao Li, Tao Li, Cheng Wang
State Key Lab of Explosion Science and Technology, Beijing Institute of Technology Beijing, China

High resolution simulation of coal methane hybrid detonation

Xinzhuang Dong[(a)], Cheng Wang[(b)]
a. Chinese People's Armed Police Forces Academy, China
b. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Motional characteristic of underwater explosion bubble near circular hole of solid wall

Jian Xue, Cheng Wang
State Key Lab of Explosion Science and Technology, Beijing Institute od Technology, China

17:00 Close of Conference

SESSION 1.1

KEYNOTE ADDRESS & SYNOPSIS

THURSDAY, 14 DECEMBER 2017
09:30 – 11:00

CHAIR

M Moatamedi
The International Society of Multiphysics

Thursday, 14 December 2017
09:30 – 11:00

Keynote Address

Design Evolution of Large Airliners

Thurai Rahulan
BSc (Hons), PhD, AMIMechE, FRAeS
University of Salford
United Kingdom

Starting with the history of air transport over a century, the development of efficient aerofoils and wing geometry will be discussed along with aerodynamic stability, equilibrium requirements and the birth of the empennage. The properties of the Earth's atmosphere will be examined next with a view to maximising the overall cruise efficiency in addition to comparing the performance characteristics of turboprops and fanjets. Consideration of the safety features will then be used to illustrate the development of the fuselage configuration along with the selection of the type, the number and the location of engines around the airframe. As the physical dimensions increase, the airframe flexural problems become more pronounced and methods which enable the designer to analyse these characteristics will be discussed. Once the basic layout has been formulated for cruise conditions, lift enhancement devices for low speed flight needed for safe take-off and landing will be explained and the talk will be concluded with a brief look at the integration of the auxiliary systems.

SESSION 1.2

INDUSTRIAL APPLICAIONS

THURSDAY 14 DECEMBER 2017
11:30 – 13:00

CHAIR

P Chen
Beijing Institute of Technology
China

TRENDS IN ADVANCED MANUFACTURING

Athanasios G. Mamalis
Project Center for Nanotechnology and Advanced Engineering, NCSR "Demokritos". Greece

In manufacturing technology six main elements are identified: the enforced deformation to the material, i.e. the processing itself; the interface between tool and workpiece (friction/lubrication, tool materials properties, surface integrity of the product); the materials testing and quality control before and after processing; the machine tool design and performance; the techno-economic aspects (automation, modeling and simulation, computer integrated manufacturing, energy conservation and recycling, environmental aspects).

In this invited paper of the Multiphysics 2017, presented are some trends and developments in advanced manufacturing of advanced materials from macro- to nanoscale under low/high speed impact and shock loading, an outcome of the over 40 years very extensive work on this field performed by the author and his research international team. Briefly outlined are industrial applications related to: Net-shape manufacturing, mainly, precision/ultraprecision engineering, carried out by machine tools with very high accuracy, and nanotechnology processing, defined as the fabrication of devices with atomic or molecular scale precision by employing advanced energy beam processes that allow for atom manipulation

- Biomedical engineering, with nanoparticles employed for targeted delivery of diagnostic and therapeutic agents in oncology, as well as crash biomechanics related to active safety;
- Structural Crashworthiness of vehicles, related to surface transport and aeronautics, that provide with the mechanism by which a proportion of impact energy is absorbed by the collapsing structure, whilst a small amount is transferred to the passenger in order to improve the crash resistance of the vehicle associated with the passive safety;
- Energy and environmental aspects, related to high- and low--Tc superconductors, as well as to the effect of nanotechnology and automotive industry and its supply chain on climate change;
- Safety from counter-terrorism, with investigations towards the detection of explosives, since explosives are the chosen weapons for terrorist attacks targeting any populated area.

EXPERIMENTS AND SIMULATIONS ON LOADS OF CLOSE-PROXIMITY UNDERWATER EXPLOSION

Fengjiang An, Xu Li, Jinhe Li, Cheng Wu
School of Mechatronical Engineering, Beijing Institute of Technology, China

The shock wave and detonation gas of near field underwater explosion are investigated experimentally and numerically. A spherical TNT charge of radius 35mm is detonated in a 800mm×800mm water tank. The framing & scanning ultra-high speed photography system are applied to obtain the trajectories of shock wave and detonation gas in its initial 80 microseconds. The Arbitrary Lagrangian–Eulerian (ALE) method using LS-DYNA software is applied to simulate the processes of close-proximity underwater explosion for varied spherical charges. Comparisons with the experimental tests are conducted to verify the results of numerical solutions. Some preliminary results detailing the loads subjected to near field at play, including the shock wave, detonation gas, are presented in this study. The engineering formulas of velocities and pressures for shock wave and detonation gas are suggested.

Underwater explosion, shock wave, detonation gas, ALE, framing & scanning photography

EXPERIMENTAL STUDY ON THE GAS FOIL BEARINGS AIR COOLING BASED THERMAL MANAGEMENT METHOD

Jakub Roemer, Michal Lubieniecki, Adam Martowicz
AGH University of Science and Technology, Poland

Gas Foil Bearings (GFB) are alternative solution for high speed rotating machinery such as micro-turbines. Due to their oil-free operation, low frictional moment and relatively long Mean Time Between Failures, the GFBs are tempting alternative for supporting rotor shafts in electric generators used e.g. in distributed energy resource systems. In operating GFB lubrication is provided by surrounding air, which makes them much less sensitive to the temperature changes compared with liquid-lubricated bearings where grease degradation due to excessive temperature is the limit. Although the GFBs can operate in wide temperature range, they are vulnerable for issues related to thermal instabilities. The specific construction of GFBs significantly reduces their ability to heat dissipation through their bushing. More than 50% of the total generated heat has to be removed from the bearing through the air leakages. In normal operational conditions, this mechanism is sufficiently effective

however can be dramatically limited by excessive temperature gradients which may occur in the support structure of the bearing. Developed temperature gradients may lead to thermal instability and further malfunction of bearing and consequently to destroying the whole machinery.

The work presents research on temperature distribution control method for a GFB based on air cooling. The experiments were performed on a prototype installation consisting of air supply and measurement and control system. The specially designed GFB bushing consisting of 3 air nozzles, and 21 thermocouple sensors is presented. Temperature gradient was obtained internally with the use of specially constructed shaft with resistive heaters and externally by a hot air jet. The work shows the effectiveness of the presented air cooling method for temperature control in GFBs.

This work has been supported by the AGH University of Science and Technology, WIMiR, research grant no. 15.11.130.610 and 11.11.130.560.

gas foil bearings, thermal gradient, thermal instability, air cooling

ANALYSIS OF STRESSES AND SURFACE TOPOLOGY OF DYNAMICALLY AGITATED FLUIDS

Daniel Brunner[a], Mirjam Clemens[b], Fabian Sager[b], Heike Cremer[b], Gernot Boiger[a]
a: ICP Institute of Computational Physics, School of Engineering, Zurich University of Applied Sciences
b: F. Hoffmann-La Roche Ltd

Agitation of fluids in vials is routinely performed in order to test the suitability of a substance for transport. Many kinds of degradation phenomena can result from such agitation. The specific shear stresses and degradation mechanisms are in many cases not thoroughly understood yet. Studying the shear stress situation due to agitation is an essential step towards understanding degradation mechanisms and specific sensitivities.In order to do this, an OpenFOAM based model has been set-up, using the two phase volume-of-fluid approach within OpenFoam's interFoam solver as well as a frame of reference. Two validation cases have been performed. Firstly, the transient behaviour of the volume-averaged shear stresses in an orbitally shaken fluid have been compared to literature results. Secondly, the structure of the surface waves has been compared to experimental results with water. The developed model has been used to conduct a parameter study for vertical shaking conditions. Thus the

shear stress distribution at different excitation frequencies and amplitudes has been investigated.

Fluid mechanics, two phase

SESSION 1.3

ADVANCED SIMULATION TECHNIQUES

THURSDAY 14 DECEMBER 2017
14:00 - 15:30

CHAIR

B Alzahabi
Al Ghurair University
UAE

DUAL-HORIZON PERIDYNAMICS

Timon Rabczuk[(a)], Huilong Ren[(a)], Xiaoying Zhuang[(b)]

a. Bauhaus University Weimar, Institute of Structural Mechanics, Germany

b. University of Hannover, Institute of Continuum Mechanics, Hannover, Germany

A dual-horizon peridynamics (DH-PD) formulation for dynamic fracture is presented. DH-PD naturally includes varying horizon sizes and completely solves the ‘ghost force’ issue. Therefore, the concept of dual horizon is introduced to consider the unbalanced interactions between the particles with different horizon sizes. The present formulation fulfills both the balances of linear momentum and angular momentum exactly. Neither the ‘partial stress tensor’ nor the ‘slice’ technique is needed to ameliorate the ghost force issue. It will be shown that the traditional peridynamics can be derived as a special case of DH-PD. All three peridynamic formulations, namely, bond-based, ordinary state- based, and non-ordinary state-based peridynamics, can be implemented within the DH-PD framework. Our DH-PD formulation allows for h-adaptivity and can be implemented in any existing peridynamics code with minimal changes. A simple adaptive refinement procedure is proposed, reducing the computational cost. Two-dimensional and three-dimensional dynamic fracture examples including the Kalthoff–Winkler experiment and plate with branching cracks are tested to demonstrate the capability of the method. Finally, the method is extended to model fracture in composites.

dual-horizon, peridynamics, composite material

OZONE LAYER THICKNESS CALCULATIONS BASED ON ATMOSPHERIC RADIATIVE TRANSFER MODELLING; A CASE STUDY OF RADIATION MEASUREMENTS FROM TROMSØ, NORWAY (69.7N, 18.9E)

Kåre Edvardsen
UiT-The Arctic University of Norway, Tromsø, Norway

Ultraviolet (UV) and visible solar radiation are both important force factors with respect to meteorology, atmospheric chemistry, oceanography and biology. From a meteorological point of view, it is important to have knowledge about how changes in the radiative force factors like clouds, aerosols and albedo affects the photochemical and radiation balance in arctic regions in the long term. Satellite measurements provide ozone layer thickness data globally on a daily basis, but still there is a need for reliable ground based measurements for satellite data assessment. The standard method to estimate the ozone layer thickness is to measure the absorption of UV-light with optical instruments. Such instruments are available from a few manufacturers and are in the price range of around 50.000,- up to 200.000,- EUR, which makes it quite expensive if you are running a network of instruments. In Norway, there are 9 sites measuring ozone data, and some of the instruments are more than 20
years old, and need to be replaced. The aim of this study is to see if there is a low cost alternative to the expensive instruments, by utilizing low cost equipment for the measurements and Radiative Transfer Modeling to analyze the data and extract information about the ozone layer thickness. The instrument in Tromsø has a cost of less than 2500 EUR, which may make it affordable for a larger community. The measurements have been going continuously since the beginning of May 2017 at a 1-minute resolution. The data has been compared with satellite and nearby ground based data at the quality ensured ALOMAR-observatory (Andøya, Norway) 110 km away. Preliminary results show an agreement with the ALOMAR-data is within 5% when comparing daily mean data.

Ozone, Radiative Transfer Modelling (RTE), Spectroscopy

UMERICAL SIMULATION FOR SOIL SURFACE EXPLOSION PROBLEM BY SPH METHOD

Yoshikazu HIGA[(a)], Hirofumi IYAMA[(b)], Ken SHIMOJIMA[(a)], Osamu HIGA[(c)] and Shigeru ITOH[(d)]

a. Dept. Mech. Sys. Eng., Nat. Inst. Tech., Okinawa College

b. Dept. Mech. Intel. Sys. Eng., Nat. Inst. Tech., Kumamoto College

c. Sci. Tech. Div., Nat. Inst. Tech., Okinawa College

d. Emeritus Prof., Kumamoto Univ. & Nat. Inst. Tech., Okinawa College, Japan

To clarify and visualize the fragments behavior such as shells, explosives and soils at a time of blasting of the unexploded ordnance, the computational simulation for the explosion problem at soil surface has been constructed and performed using Smoothed Particle Hydrodynamics (SPH) schemes by HyperWorks-RADIOSS (®Altair) software.

In this report, a study about the effect of the different soil characteristics on the fragments behavior is performed. Here, the authors are highlighted the specific soils in Okinawan Island so called Jahgaru and Shimajiri-Mahji.

Results of computational simulations performed with different amounts of explosive on the soil surface are presented. By conducting a series of computational simulations, it has been observed the fragments behavior significantly depending on soil characteristics and amounts of explosive.

Computational Simulation, Soil Characteristics, SPH, Fragment Behavior

DYNAMIC MODELING OF IONIZED OXYGEN DISTRIBUTION WITHIN POWDER COATING PISTOLS

Gernot Boiger
Zurich University of Applied Sciences, Switzerland

It is well known that a stable corona of ionized oxygen forms in the proximity of electrodes within powder coating pistols. What remains unclear though is the extention and shape of the ionized oxygen field, as well as its interaction with geometric boundary conditions. Therefore a Eulerian charge transport model was created within OpenFoam. It considers convective, diffusive and electro-static effects on charge distribution, as well as a dynamic coupling to the electric field. The latter is shown to be essential for obtaining a stationary solution, which amounts to a stable corona. Analysis of the result reveals unexpected yet plausible charge distribution effects within the application. The solution is validated by comparison to the point-wise measurement of potential field strength evolution on the outside of the pistol. Furthermore the new model is applied within a coupled powder coating solver which includes flow-, electric- and particle dynamic effects. This Multiphysics solver is then used to predict the corona-effect on particle charging-efficiency, as well as to compare pistol-design options and their respective impacts.

corona, charge transport, OpenFoam, powder coating, Multiphysics solver

SESSION 1.4

POSTERS

THURSDAY 14 DECEMBER 2017
16:00 - 17:30

NUMERICAL SIMULATION LED DESIGN OF THE PLANAR SHOCK RECOVERY ASSEMBLY

Tan Zhen, Chen Pengwan, Zhou Qiang
Beijing Institute of Technology, China

Shock recovery technique has been widely used in the investigation of phase transformation behavior of materials under shock compression conditions. However, how to determine the dimension of the sample container to ensure that all the sample inside would be subjected to high pressure is still a challenge. In this paper we introduced our resent achievement on the design of the planar shock recovery assembly. Here, numerical simulation has been used to design the planar shock recovery assembly, the effect of longitudinal and lateral release wave have been taken in consideration when determine the geometry and dimension of the assembly. The results suggest that by change the ratio of the flyer diameter to sample diameter (d/ds) and the ratio of the sample diameter to sample thickness (ds/h) most of the sample inside the sample container would be subjected to high pressure.

numerical simulation, shock wave, shock recovery assembly

BEHAVIOR OF BUBBLE JETTING AND LOADING ON AIR-BACKED PLATE SUBJECTED TO NEAR-FIELD UNDERWATER EXPLOSION: EXPERIMENTS AND SIMULATIONS

Fengjiang An, Lihui Dai, Dongyu Xue, Yuxia Zhang
School of Mechatronical Engineering, Beijing Institute of Technology, China

The effect of bubble jetting from an underwater explosion can result in significant late-time loading compared to the initial shock loading. However, much more attention has been paid to understand the shock wave load and its damage mechanism instead of the complicated loads induced by the bubble dynamics. The loading experienced by a submerged structure in close-proximity to an underwater explosion is investigated with an experimental and numerical study. Laboratory-scale experiments in which small scale charges were detonated in close proximity to an air-backed steel plate are conducted. To recording the loading, the flat plate target is instrumented with strain gauge. Also, High speed camera is used to track the dynamics of the gas bubble as it interacted with and loaded the target structure. The Arbitrary Lagrangian–Eulerian (ALE) method using LS-DYNA software is applied to simulate the entire process of close-proximity underwater explosion. Comparisons with the experimental tests are conducted to verify the results of numerical solutions. Some preliminary results detailing the complex loading phenomena at play, including the bubble pulse, pressure wave and bubble jetting, are presented in this study. Especially, the bubble jetting formation, and the strain response induced by the shock wave and the reloading of bubble jetting.

Underwater explosion; bubble jetting; fluid structure interaction; ALE method

DEVELOPMENT OF SHOCK WAVE GENERATING DEVICE USING HIGH-VOLTAGE PULSED DISCHARGE

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We have done research for a generating technology of the underwater shock wave caused by an electrical discharge. On the basis of this technology, we aimed that the underwater shock wave applies to food processing. However, the conventional shock wave generator has disadvantage such as a slow generation cycle, an excessive discharge energy. Purpose of this study is to increase a peak power of discharge by decreasing a discharge energy, compressing a discharge pulse.
Experimental circuit was constructed based on DC high voltage power supply and Marx generator. And discharge current and voltage were measured. What is more, underwater shockwave strength were measured.
As a result, the peak voltage was about 12 [kV], the peak current was about 30 [kA], and peak power was about 32 [MW]. Furthermore, a current rise time was 28 [us], and Shockwave pressure by Marx generator was 60.1 [MPa]. In contrast, the current rise time of the conventional type shockwave generator was 80 [us]. And, Shockwave pressure by conventional type shockwave generator was 26.8 [MPa] at position 10 [mm] from electrode. By these results, Marx generator was able to obtain higher pressure than conventional type. In the future work, We evaluate effect to foods by the shockwave.

Underwater shockwave, Underwater spark discharge, Food processing, Pulse compression

NUMERICAL SIMULATION ON STRUCTURE EFFECTS OF GAS EXPLOSIONS IN VESSELS

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This paper presents a simulation study on the methane-air mixture explosions through using the eddy-dissipation concept (EDC) model in FLUENT. The aims are to investigate the structures effects and characteristics of methane-air mixture explosions in a spherical vessel, cylindrical vessel and different systems of cylindrical vessels connected with pipe. Meanwhile, changes of flame temperature and airflow velocity in the linked vessels are simulated and analyzed. The results suggest that the effect of structural changes of a single vessel on the gas explosion intensity is clear, and the explosion intensity of a spherical vessel is greater than that of a cylindrical vessel. The simulation results of different structural forms of a cylindrical vessel connected with pipelines show that the time to reach the peak value of explosion pressure is the shortest in the linked vessels, besides the explosion pressure rising rate is highest at the vessel's center. For the linked vessels, after the gases of the primary vessel are ignited, the airflow ahead of the flame propagates to the secondary vessel, and the maximum airflow velocity of every monitoring point in the linked vessels increases. When the gases are ignited in the secondary vessel, there is detonation occurs in the linked vessels that leads to a severe secondary explosion in the secondary vessel. The studies on structure effects of methane-air mixture explosions can provide an important reference for the safe design of industrial vessel.

Methane-air mixture explosions, Characteristics of explosion, Linked vessels, Structure effect, Numerical simulation

COMPARISON OF CELL TRANSFERABILITY IN SHOCKWAVE MOLDED REPLICA SPECIMEN

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c. Sojo University, Japan

The shock wave metal molding known as "The Explography" is the technique of the three-dimensionally molded metal material by a high-speed deformation. The fine mold processing for metals are possible due to the high-speed deformation by the shock wave which is a high pressure that propagates at supersonic speeds. The feature of this technology is that it does not require the strength of the type despite the metal forming. For example, taken also as a mold form type the fresh leaves of the plant, even fine veins of leaves and cells, it is possible to take out as the three-dimensional replica on the metal. This technique called "The Explography" makes it possible to know the shape of the biological material by using tactile sense by setting biological materials such as plants as "original mold".In this research, we study the possibility of barrier - free specimen production, mainly for visually impaired people.

The number of leaf cells transcribed on a 0.1 mm thick metal plates (aluminium, copper, silver, and so on.) by a shock wave of 157 MPa were counted and compared by scanning electron microscopy. Authors study the most suitable metallic material as a barrier-free specimen that is rich in transferability and durability, and aim to utilize it as a teaching material at the blind school.

This work was supported by JSPS KAKENHI Grant Number 16K12815.

Shock Wave, Explography

DEVELOPMENT OF FOOD PROCESSING EQUIPMENT USING UNDERWATER SHOCK WAVE

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National Institute of Technology, Okinawa College, Japan

This research aims at developing food processing equipment using underwater shockwave. In this research, the underwater shock wave is generated in water by applying high voltage to aluminum wire an explosively evaporating and expanding. In the prototype processing equipment, the discharge electrodes are driven using the air cylinders and the aluminum wire was pinched between those. But, the equipment could not stability operate for a long time due to melts of discharge electrodes. Design and fabrication of a device to solve this problem is shown. We proposed and created a design plan that adopted a hydraulic cylinder with a stronger pinching force than an air cylinder. Melting of electrodes was reduced by reduction of conductive resistance, peak pressure was enhanced. Also, the equipment was operated stability. In the future work, we will estimate the performance the equipment by measuring the shock wave strength, durability of the electrodes, effect of food processing.

Shock wave, food processing, wire explosion

SHOCK-INDUCED PHASE TRANSITION OF IRON STUDIED WITH PHASE FIELD METHOD

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The purpose of this paper is to develop phase field method in high strain rate loading to study microstructure evolution in shock-induced phase transformation of iron base material. We derived the governing equations of phase field model in the foundation of entropy functional, and the model adopted a diffusion interface, which made automatic tracking on interface possible. We added the order parameter to characterize the different phases of materials, and simulated the soften and phase transition in shock-induced loading. According to the conservation theorems and principle of entropy increasing, we established the governing equations of shock-induced phase transition in metal dielectric. Then we discretized phase field model by using high order difference scheme, introducing the artificial viscosity, and obtained the numerical solution of the phase field model. Compared the numerical value with the theoretical solution of thermodynamic parameter, the accuracy of the developed phase field model was verified. Based on the model described above, we study the polymorphic phase transition of iron-base alloy induced by one-dimensional shock wave. The results of simulation showed that the pressure for phase transition reduced compared with that under the static pressure and room temperature, which demonstrated the effect of temperature rise in shock-induced loading. Considering the spatial and temporal distribution of each parameter field and the Hugoniot data for iron, we further analyzed the coupling effect of wave and phase transition by tracking the changes of pressure and speed in each unit. The simulation results fitted well with the experimental results, which indicated that the phase field model we developed was successful, and it would help people to understand the microstructural evolution of metallic materials under the shock wave.

Impact dynamics; Phase field method; Shock-induced phase transition; Shock wave loading; Diffusion interface

FSI OF VISCOSITY MEASURING MECHANICAL RESONATORS: THEORETICAL AND EXPERIMENTAL ANALYSIS

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Measuring viscosity online in processes is crucial to maintaining the quality of many chemical and biological processes. The damping induced by the liquid around the resonator is used to determine the viscosity of the liquids. Typical viscosity sensors are probe style and obstruct the piping system, disturbing the flow and creating a potential source of contamination in critical processes. The eventual goal is to design a non-intrusive sensor capable of accurately measuring the viscosity of the liquids without influencing the flow within the pipe. In order to get a deeper insight into the functionality of such a device, a mathematical model has been developed describing the mechanical vibration coupled with the fluid-structure interaction (FSI) models. The shear stresses at the wall have been analysed using the computational fluid dynamics tool OpenFOAM and have been integrated into the derived model. For validation, the model has been tested against the samples. The model is capable of accurately predicting the response of the sensor and can be used as an optimization and design tool.

FSI, viscosity, mechanical resonators

FLUORESCENT MARKING OF ROADS IN HIGH-NORTH

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The project objective is to investigate into luminescent coating materials that can be used in marking the roads in high-north. The idea of the project is not entirely new, and efforts have been worldwide to find an energy efficient solution to the street lights. Earlier work conducted in the Netherlands showed quite promising results. However, the challenges include weatherproofing the coat such that it can withstand the harsher conditions such as rain, temperature changes, UV exposure from sunlight. The conditions will be even more stringent in the high north since the roads are exposed to snow, ice, and traffic with studded-wheels.
In this work, we are proposing to use polyurethane-based coating materials with added luminescent materials. The work will be carried out by appropriately mixing the materials to obtain the desired luminescent as well as physical properties. The polyurethane-based coats are known for their durable performance and hence used in industries such as aviation, automobiles, etc.

fluorescent marking, polyurethane-based coatings, high-north

DETECTION OF CRACKS AND POTHOLES IN ROADS USING INFRARED THERMOGRAPHY

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Many remote sensing techniques can be used to identify the cracks/voids on the road surfaces. The given research focuses on applying infrared thermography (IRT). IRT technology can detect features based on the different thermal signature. This method would be an excellent tool for detecting the fracture/cracks. It is because of the reason that the naturally occurring water (rain, snowmelt, etc.) seeps into fractures/cracks. The water has different heat capacity than the material of road surface, and will not undergo cooling or heating as fast as roads surface, hence develop a qualitative thermal signature. This thermal image can be captured using IRT. Also, if the crack is in-depth and invisible from the surface may also be detected using IRT.
One of the most common reason for the road damages in high-north is the seepage of water, followed by the freezing/thawing cycle. Cracks have various topographical features and can be categorised based on their shape, depth, and propagation rate. One of the examples of such crack is referred to as a 'crocodile crack'. If left untreated, the 'crocodile crack' turns into even greater damage, such as potholes. Maintenance and repair cost of potholes is far larger than repairing the crack. Hence pre-emptive detection is essential for a cost-effective and an efficient solution.

Cracks, Roads, Infrared Thermography (IRT)

MODELLING AND SIMULATION OF THE HDPE PYROLYSIS PROCESS

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Department of Engineering and Safety, UiT The Arctic University of Norway, Tromsø, Norway

Pyrolysis is a thermochemical decomposition of organic compounds such as High-density polyethylene (HDPE) plastics. The product of the HDPE pyrolysis is usually diesel with other wastes (such as black carbon, etc.). Pyrolysis reaction is essentially a decomposition reaction performed at elevated temperatures in the absence of oxygen.

The paper aims to describe some of the primary driving reactions in a pyrolysis and to model and simulate the process. In pyrolysis, on a molecular level, there are many complex reactions taking place. To define all the reactions and include them in the model is very expensive and time-consuming.

In this paper, we will limit the reactions to three different reactions, namely β−scission, hydrogen abstraction and chain fission. To be able to simulate a chemical reaction, reaction equations are needed. These set of equations are provided in the literature. We have solved them in MATLAB® using ordinary differential equation (ODE) solver. The solution represents the rate of the reaction rate and the product outcome. The key to the solution are the reaction constants. These may be varied to simulate various reactor conditions.

HDPE, Pyrolysis, Reaction Rates, MATLAB®, ODE solver

DETECTION, IDENTIFICATION AND SIZE DISTRIBUTION OF MICRO-PLASTIC PARTICLES

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Pollution by micro-plastic in ecosystems is one of the major problems we are facing now, especially in marine environment. Many studies are going on the detection of different micro substances that pollute our environment. Micro-plastics are among the more frequent pollutants of the sort in aquatic ecosystems.
There have been some studies earlier on methodologies to detect and identify micro-plastic particles, in the order of one micrometer in environmental samples. Raman spectroscopy in combination with Raman spectral imaging is one of these methodologies. In theory, it is proven that the Raman spectral imaging can be used for the analysis of micro-plastic, but the applicability of this method has yet to be demonstrated.
The aim of this project is to find the application of Raman microscopy in combination with Raman spectral imaging for the detection and identification of micro-plastic particles in ecosystems. In Raman spectroscopy, the sample often will produce unwanted fluorescence excited by the laser producing the Raman spectrum. Hence, more research is necessary to find the optimum laser wavelength for a compromise between suppressed fluorescence and low signal intensity for assessments of micro-plastics in environmental samples.

Micro-plastics, Raman spectroscopy, Raman microscopy, Raman spectral imaging

AN FEM-BASED AI APPROACH TO PARAMETER IDENTIFICATION FOR LOW VIBRATION MODES OF HAWT COMPOSITE ROTOR BLADES

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b. Taras Shevchenko
c. Brunel University London

An artificial intelligence (AI)-based approach to construction of a beam-type simplified model of a horizontal axis wind turbine (HAWT) composite blade is proposed hinging upon simulations run in parallel using the finite element method (FEM). The model allows effective and accurate description of low vibration bending modes taking into account the effects of coupling between flapwise and lead-lag modes of vibration transpiring due to the non-uniform distribution of twist angle in the blade geometry along its length. The identification of model parameters is carried out on the basis of modal data obtained by more detailed finite element simulations and subsequent adoption of the 'DIRECT' optimization algorithm. Stable identification results were obtained using absolute deviations in frequencies and in modal displacements in the objective function and additional a priori information (boundedness and monotony) on the solution properties.

Low-dimensional beam model, AI, optimization algorithm, vibration coupling, flapwise vibration, lead-lag mode

SPH SIMULATION OF ANNULAR JET FORMATION AND PENETRATION ASSOCIATED WITH UNDERWATER EXPLOSION

Zhifan Zhang, Cheng Wang
State Key Lab of Explosion Science and Technology, Beijing Institute of Technology, China

Three phases are included when a target is penetrated by a shaped-charge jet, namely, charge detonation, formation of metallic jet and its penetration into the target. An annular jet may cause more serious damage to structures than the general shaped-charge jet. A meshfree methodology - Smoothed Particle Hydrodynamics (SPH) - is suitable for solving problems with large deformations thanks to its mesh-less nature. Hence, the SPH method was utilized to simulate the process of the annular jet formation and penetration into underwater structures in this paper. First, a modified scheme for approximating kernel gradient (kernel gradient correction, or KGC) was used in the SPH simulation of the annular jet penetration into the target; its validity and feasibility was verified by the comparison of numerical and experimental results. Second, the entire process of charge detonation, the jet formation as well as the penetrating effects was simulated by the the mentioned developed method; comparison for formations and penetrations into the target of the general and annual jets was studied. Third, a fluid around the shaped charge was included into analysis, and damage characteristics of the plate exposed to air and water on its back side were compared.

SPH; kernel gradient correction; annular jet; underwater explosion; penetration

STUDY OF GROOVED WARHEAD STRUCTURE ON PERFORMANCE OF WARHEAD FRAGMENT DISTRIBUTION PATTERN

JING Qingbo
Xi’an Modern Chemistry Research Institute, china

Fragment distribution pattern is a major factor for fragmentation warhead of medium diameter gun weapon, two different grooved warhead structures on the outer surface of warhead are proposed in this paper to improve warhead fragment distribution pattern. Experiments are performed to validify effectiveness of said efforts, and results show diamond-grooved warhead structure produces more fragment distribution density around warhead axis than parallel-grooved warhead structure, while keeping identical fragment projecting angle and dispersion angle. Finally, optimum depth on the surface of diamond-groove warhead structure is also obtained through experiments, showing impressive capability to withstand barrel gunpowder pressure more than 300 hundred million pascal per square meter.

fragment formation, parallel-grooved warhead, diamond-grooved warhead structure

AN IMPROVED GURNEY MODEL TO PREDICT INITIAL VELOCITY OF PARALLEL-MOVING ROD-SHAPED FRAGMENTS

Xue Biao, Jing Qingbo
Xi'an Modern Chemistry Research Institute, China

An improved Gurney model considering explosive energy waste originated in the process of driving rod-shaped fragment revolving, is proposed herein to predict initial velocity of parallel-moving rod-shaped fragment using parameters such as Gurney constant, mass ratio of explosive charge to rod-shaped fragments, and slanting angle of rod-shaped fragments arrangement. Static arena test was performed to evaluate validity of said improved model, and predictions based on the improved Gurney model exhibit impressive consistency with test result, providing a reliable methodology to predict initial velocity of parallel-moving rod-shaped fragments in the engineering development of controllable discrete rod warhead.

Controllable discrete rod-shaped fragment, Gurney model, mass ratio of explosive charge to rod-shaped fragments, slanting angle of rod-shaped fragments arrangement, initial velocity of parallel-moving rod-shaped fragment

DYNAMIC RESPONSE OF A DOUBLE CYLINDRICAL SHELL UNDER INTERNAL EXPLOSIVE LOADING

Cai Ze, Long Renrong
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Explosion containment vessel is a pressure vessel that works in extreme conditions. The research of this kind of structure involves two parts of the problem: the calculation of implosion loading and the dynamic response of shell, and blast flow field and dynamic response of shell are coupled, which makes the research of the explosion container more complex than the static pressure vessel. Based on ANSYS, a finite element model of double layer cylindrical shell with composite/metal subjected to internal explosion loading was established. The experiments of different explosive charge were numerically simulated using ANSYS/LS-DYNA, and the rule of dynamic response which was in different mass ratio of shell and explosive was shown through analyzing the stress, strain and displacement variation of each layer of the shell. Moreover, a physical model to the circular of the cylindrical shell which was established by theoretical analysis in this paper can explain the results of experiment and numerical simulation well within a reasonable error range. Further, the physical model may provide a useful basis to the research of exploring the interaction mechanism of the double shell explosion containment vessel.

Explosion containment vessel, shell, finite element, interaction mechanism

THE RESPONSE CHARACTERISTICS OF WARHEAD FRAGMENT IMPACT ON SHIELDED H6 EXPLOSIVE

Jun Peng, Baohui Yuan, Xingyun Sun, Qingbo Jing
Xi'an Modern Chemistry Research Institute, China

For studying response characteristics resulting from fragmentation warhead fragment impact on shielded H6 explosive. H6 explosive has been shielded with Q235 steel, what was impacted for cuboid tungsten fragments at the velocity range of 2000-2200m/s launching from 25mm ballistic gun, with different quality and length-thick ratio of square, The process of impact response was observed by high-speed photography. The maximum diameter and duration of the fireball as well as destruction of shielded H6 explosive were recorded, then corresponding features of shielded H6 explosive were analyzed accordingly. Furthermore, the mechanism of H6 explosive responses was analyzed based on the theory of explosive impact initiation. Results show that it mainly includes combustion, deflagration and detonation for response features of targets, and it has highest probability for deflagration. Adiabatic shear effect was regarded as the functional mechanism, which could produce different response characteristics. Deflagration reactions could be sparked in which of the situations the quality of fragments was no less than 10g. what's more, The most violent deflagration reactions could be sparked under the certain condition that the length-thick ratio of fragment was about 1.6.

Fragment, shielding H6 explosive, impact response

SIMULATION AND EVALUATION OF DAMAGE EFFECT OF RING DAMAGE UNIT TO KINETIC ENERGY INTERCEPTOR

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Naval University of Aeronautics, Naval University of Engineering, China

In this article, we study the damage effect of ring damage unit-kinetic energy ring-on kinetic energy interceptor. Through the vulnerability analysis of the kinetic energy interceptor, the four vulnerable sections of the kinetic energy interceptor are obtained. Using Explicit Dynamic ANSYS module, the physical model of the vulnerable sections is established and the kinetic energy is simulated at three different angles for the penetration of the vulnerable sections. Through the analysis, the damage effect of the kinetic energy ring on the vulnerable sections of the kinetic energy interceptor is obtained, which is of reference value for the design and development of new type of ammunition.

Ring damage unit, kinetic energy interceptor, penetration, simulation

EFFECTS OF CRYSTAL MORPHOLOGY ON IMPACT SENSITIVITY OF LLM-105 BASED EXPLOSIVES

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LLM-105 (2,6-diamino-3,5-dinitropyrazine-1-oxide) is an insensitive high explosive which has performance between that of HMX and TATB. The LLM-105 crystal morphology are dependent on its synthetic, recrystallization and processing history. It is thermally stable and fairly insensitive to shock, spark and friction, but the impact sensitivity depend on the crystal morphology. A dislocation based viscoplasticity model is developed for LLM-105 crystal, which accounts for the dislocation evolutions in crystal interiors and crystal walls and strain-rate and temperature dependent work hardening. Three different crystal morphologies (Cubic, Icosahedral, Rodlike) LLM-105 based explosives models were constructed and subjected to an impact pressure of 100 MPa. Effects of crystal morphology on thermo-mechanical behavior and impact sensitivity of LLM-105 based explosives were analyzed. Dislocation density of both crystal interiors and crystal walls in the rodlike explosive increases slower than that in the cubic and icosahedral explosives. Both the accumulated shear strain and the temperature rise in the rodlike explosive are less, which indicates the rodlike explosive is less sensitive.

Impact sensitivity, Mesoscale, LLM-105, Dislocation

LASER IGNITION AND COMBUSTION MECHANISMS OF MAGNESIUM SINGLE PARTICLES

Lu Sun, Shi Yan, Yachen Wu, Jinggu Cao，Jinlong Zhang

State Key Laboratory of Explosive Science and Technology, Beijing Institute of Technology, China

Ignition and combustion of small single particles of magnesium in the atmosphere of air is considered. This investigation is of interest for both basic combustion science and applications to rocket engines. A fiber-coupled semiconductor laser was used for heating to ignition of the particles. The experiments were conducted at room temperature and pressure and the reaction process were monitored by high-speed camera and infrared thermometer at the same time. It can be clearly observed that the whole process is divided into three stages. The first stage, a layer of dark gray substance is generated on the surface of magnesium, and the particles lose the metallic luster. In the second stage, the temperature of the magnesium particles reach the melting point and remain to be constant as the endothermic heat continues. Sparkles appear at this stage because liquid phase of magnesium broke the layer and reacts with the air. In the third stage, the temperature of the particles rapidly increases to the boiling point of magnesium, and the gas phase combustion occurs. The surface of the particles is surrounded by the flame. A 2D model of ignition and combustion of magnesium were established. The influence of particle size on the critical ignition energies, ignition delay times, and burning times were analyzed with numerical calculation. The results indicate that as the particle size increase, the critical ignition energies, ignition times and burning times become larger. The ignition of Mg in air is controlled by chemical kinetics and that its combustion is controlled by diffusion in gas phase.

Magnesium Particle, Ignition, Combustion, Experiment, Mechanism

MECHANICAL AND IGNITION OF PBX EXPLOSIVES BASED ON MICRO-CRACKING MODEL

Yanqing Wu
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

A modified viscoelastic-statistical crack mechanical model (Visco-SCRAM) has been developed to describe the dynamic responses of polymer-bonded explosives (PBXs) under low-velocity impact. An isotopic-type hardening plastic model was added to describe the plastic deformation of PBXs. The damage evolution was calculated by the generalized Griffith instability criterion with the most unstable orientation for cracks that are isotropically distributed in the material. To predict ignition response of explosives, a set of sub-models, which account for heating generated by interfacial friction on shear cracks, melting, ignition, and fast burning next to the crack surfaces, were imported. Simulated results show that the current model predicted a larger value of softening-strain than Visco-SCRAM. The time when bulk temperature starts to increase is earlier than the time when microcrack hotspot temperature exhibits a notable increase. The contributions of the heat generated by localized interfacial friction, decomposition, and viscous flow on the hotspot temperature increment of the PBXs were investigated quantitatively.

PBXs; statistical crack mechanical model; damage; ignition; low-velocity impact

OPTIMISATION AND APPLICATION OF HALL EFFECT SENSOR

Houaria Bourbaba, Kadri Syham
LPDS laboratory, Bechar University Algeria, Algeria

The sensors play the role of the sense organs of the machines and thus reflect a certain perception of the surrounding physical reality. A better knowledge of this one therefore requires the development and the implementation of ever more diversified and efficient sensors. Advances in semiconductor technology have led to the production of increasingly efficient miniature Hall sensors. These sensors are now used in various applications.
The sensitivity and response of these Hall effect sensors depends on a few parameters such as structure and offset voltage and temperature. The purpose of our work is to know how to improve the performance of the Hall effect sensor based on a semiconductor by increasing its magnetic sensitivity. From the simulation results obtained, we propose some applications of the Hall effect sensor such as sorting parts, obstacle recognition or cartography.

Hall effect sonsors, detector, simulation, InAs,Ge, sensibility

LARGE SCALE AND HIGH PRECISION NUMERICAL SIMULATION OF EXPLOSION PROBLEM ON THE SUNWAY SUPERCOMPUTER PLATFORM

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b. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

Sunway TaihuLight supercomputer has become the fastest supercomputer in the world. How to use the supercomputer platform for innovative research results has become a hot research topic in the field of scientific computing. This paper is based on the current research results of the Gordon Bell Prize in 2016, the world's first operational speed of more than one billion billion times supercomputer Sunway Taihulight supercomputer instruction set and the hardware structure of the system, applicable to the development of the super large scale and high precision numerical simulation program of explosion problem. The program is used to discrete the governing equations by the five order Weighted Essentially Non-Oscillatory format and the third order Total Variation Diminishing Runge-Kutta method. The Local Level Set and Real Ghost Fluid Method interface processing method was used to deal with the multimedia interface of high density ratio, the high pressure ratio and Strong discontinuity dynamic problems. The numerical simulation typical explosion problem such as air explosion, explosion near ground and deepwater explosion is carried out. The simulation results well reflect the explosion of gas gas and gas - water interaction, which laid a good foundation for the large-scale numerical simulation of explosion problem.

numerical simulation, explosion problem, high precision, large scale

SESSION 2.1

IMPACT AND EXPLOSIONS

FRIDAY 15 DECEMBER 2017
09:30 – 11:00

CHAIR

T Rahulan
University of Salford
UK

ADVANCEMENT IN NUMERICAL SIMULATION INVESTIGATION ON EXPLOSION AND IMPACT PROBLEMS

Cheng Wang
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Explosion and impact are nonlinear problems where a variety of media, such as gas, solid and liquid, strongly interact under high speed, high temperature and high pressure conditions, formidable challenge is imposed on the theoretical and experimental research. Due to such advantages as security, confidentiality, design flexibility, environment and process controllability and high cost-effective ratio, numerical simulation becomes the main approach to investigate such problems. This paper introduces in detail the researches on high resolution computations of explosion and impact problems and multi-medium interface treatment conducted by the authors in recent years. Based on real ghost fluid method (RGFM) method and Level Set method, the computational method that can address high density and high pressure ratio is proposed. The positivity-preserving high order WENO finite difference scheme is constructed to solve the strong discontinuity and strong nonlinearity process of detonation wave and shock wave. Based on this, a high precision parallel computation code was developed for explosion and impact problems. The code can simulate problems such as gas detonation, initiation of condensed-phase explosives, detonation diffraction, shock wave interaction with bubbles, underwater explosion, jet formation and penetration. By constructing artificial solutions and comparison with experimental results, the accuracy and computation results of the computation method are validated and verified.

Explosion and impact; Numerical simulation; WENO scheme; Level Set; Positivity-preserving scheme

EFFECTS OF MICRO-BUBBLE ON UNDERWATER SHOCK WAVE GENERATION USING SPARK DISCHARGE

Osamu Higa, Kazuki Tokeshi, Shoichi Tanifuji, Shigeru Itoh
National Institute of Technology, Okinawa college, Japan

We have been developing a shock wave generation device using underwater spark discharge due to apply to food processing. When a spark discharge is generated in a water, a water is rapidly evaporated caused by high-temperature of spark, the underwater shock wave was generated by expansion of the vapor. When a few kilovolts of voltage are applied to underwater electrodes with gap about 5mm, a few hundred amperes of current carries at the gap, the gas bubble generates around the electrodes gap caused by joule heat and electrolyzation. The bubble increase stepwise with the injection energy, it is filled around the gap after tens millisecond. The spark discharge is triggered by the gas bubble, and the shock wave generates. The injected energy before the spark shifts to a heat and it becomes energy loss. Therefore, Purpose of this study is to investigate some effects to the discharge phenomenon and shockwave propagation characteristics when generating underwater shock wave by electric discharge, by generating micro-bubble and floating it beforehand in the water. By the experimental results, it shows that the time for a precursor phenomenon of electric breakdown can to shortly because electric break down induced by micro-bubble between two electrodes. Also, the shockwave applies micro-bubble, more shock waves generate by bubble collapse. But, these shock waves were weaker than initial shock wave. A shock pressure could not measure by a pressure sensor. By the research, it was shown that the effect of micro-bubble to the shock wave propagation is small, but the micro-bubble affect to the electric break down in a water.

Underwater shock wave, Micro-bubble, Dielectric breakdown, Spark discharge

CFD SIMULATION ON STUDY OF STRUCTURAL EFFECTS OF A METHANE-AIR MIXTURES EXPLOSION IN LINKED VESSELS

Yaya Zhen, Zhirong Wang, Chen Yan, Fei Jiao
Jiangsu Key Laboratory of Urban and Industrial Safety, College of Safety Science and Engineering, Nanjing Tech University, China

In the process of modern industry production, gas storage container devices are mainly assembled from various structure vessels and complicated pipelines. The different structure vessels or pipelines have an obvious effect on gaseous explosion. The vessels that store or transport flammable mixtures are often connected through a pipeline in chemical and petroleum chemical plants. In the paper, a CFD simulation was carried out to study the structural effects of the vessels and pipelines on methane-air mixtures deflagrating characteristics in linked vessels (Vessel connected with pipe). The validation of numerical model issued in the paper is validated by the experimental results. The simulation results indicate the gas flow velocity increases when the pressure wave propagates to the intersection of vessel and pipeline and the value of peak pressure decreases. When pressure wave propagates into the pipeline bend, the gas flow velocity slows down, and then it accelerates again in the straight pipe. The explosion pressure and gas flow velocity in spherical container-pipe are both higher than those in the cylindrical container-pipe structure. For spherical vessel with additional pipelines, P max value drops in the center of vessel. However (dP/dt) max value in the pipe terminal will increase in several times. So the protection of pipe terminal should be paid real attention in the industry. For the section of pipeline bend, the flame temperature in concave wall side is higher than that in convex wall side. The effect of joint position of pipe and vessel on the P max and (dP/dt) max in the linked vessel is not obvious. The conclusions provide important reference for safety design of chemical equipment.

Structural Effects, Gaseous Explosion, Linked vessels, Numerical simulation

COMPUTATIONAL SIMULATION AND PRODUCTION OF PRESSURE VESSELS FOR FOOD PROCESSING USING UDERWATER SHOCKWAVE

Ken Shimojima, Osamu Higa, Yoshikazu Higa, Shigeru Itoh
Okinawa College, Japan

The National Institute of Technology, Okinawa College(OkNCT) has developed the food processing machine using the underwater shock wave by wire discharge. Those effect were sterilization, milling flour, softening, extraction, and so on. In this presentation, the process and results of numerical analysis of pressure vessels are described. Several foods are processed by food processing machine using underwater shock waves, and the results are shown.

Underwater shock wave, Food processing, Computational simulation

SESSION 2.2

COMPOSITE MODELLING

FRIDAY 15 DECEMBER 2017
11:30 – 13:00

CHAIR

G Boiger
Zurich University of Applied Sciences
Switzerland

IMPACT TESTING AND MODELLING AN E-GLASS FIBER REINFORCED POLYMER COMPOSITE

Mustafa Güden, Kutlay Odacı, Alper Tasdemirci

Dynamic Testing and Modelling Laboratory, Mechanical engineering Department, İzmir Institute of Technology, Urla, Turkey

The polymer composites are extensively used as structural elements in armored vehicles and airplanes in which the high rate loading may easily occur. Due to relatively large sizes, the dynamic testing of these structures is rather difficult; therefore, modeling usually becomes an important tool for assessing dynamic damage formation. In present study, the projectile impact testing an E-glass/polyester composite was modelled in LS-DYNA using LS-DYNA MAT_162 material model. In order to determine MAT_162 material model parameters of the composite various quasi-static and dynamic tests were performed. The quasi-static tension test simulations were executed to obtain the optimum mesh size and damage parameters. The simulations were shown to be mesh dependent. The damage parameters' calibrations were performed by trial and error method and different parameters were obtained for tension and compression. The optimized MAT_162 material model parameters were determined through both
quasi-static and high strain rate tests. The projectile used in the impact tests was a cellular corrugated core cylinder (4 cm in diameter and 4.8 cm in length). The corrugated structure deformed almost at a constant plateau stress until about relatively large strain, imposing nearly a constant pressure to the composite plate during impact. The projectile was impacted to 25x25 cm composite plates in 2, 5 and 8 mm thick at a velocity of ~200 m s-1. The damage was found to increase as the thickness of the plate decreased. The experimental and numerical plate deflections and damage zone areas and types in the projectile impact tests were found to show well agreements. The proposed testing method can also be used in compression after impact testing the composite structures. In this case the proposed test method allows relatively high strain rates as opposite to the drop weight test usually used in compression after impact tests.

dynamic; composite; modelling; damage

NUMERICAL SIMULATION ON DISCARDING SABOT OF HYPER-VELOCITY PROJECTILE PERFORATING LAMINATED PINE WOOD TARGET

Chu Yunlin[(a)], Shen Chao[(b)], LIU Liu[(c)], Wu Wenyou[(a)],PI Aiguo[(a)],

a. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

b. Beijing HIWING Science and Technology Information Institute

c. Southern Sichuan Machinery

In order to obtain accurate test data in sub-caliber launching high-velocity penetration test, discarding sabot is an effective technique to reduce the testing auxiliaries' effects on the penetration results. In this paper, numerical simulation were carried to investigate the way of using laminated pine target as the equipment to discard sabot. Firstly, parametric study for an orthotropic material model of wood is performed combining with the high-velocity penetration test data from literature, which shows that the numerical simulation method is reliable. Then based on those parameters, a series of simulations were performed to analyze penetration/perforation laws for a projectile with sabot penetrates pine wood target under different interaction conditions. The results of numerical simulation show that, for normal penetration, the sabot of the sub-caliber projectile body can be discarded effectively by designing the laminated wood target reasonably, and the high-velocity penetrator can vertically shoot the target, and the velocity attenuation of body is controllable. Besides, for oblique penetration, the impact yaw of the high-velocity penetrator will be enlarged by the laminated target. With the increase of initial impact velocity, the loss of kinetic energy increases when the projectile perforates the laminated wood target, which indicates that the wood material has an obvious strain-rate hardening effect.

explosion mechanism, hyper-velocity penetration, sabot discard

STATE-OF-THE-ART TECHNIQUES IN CRACK DETECTION AND UTILIZING INNOVATIVE MATERIALS FOR THE REPAIR AND MAINTENANCE OF ROADS

H Khawaja,
UiT The Arctic University of Norway

This work is looking into the issue of repairing and maintaining the roads using innovative materials in the Arctic region. We have conducted preliminary studies at UiT The Arctic University of Norway and found a suitable material that has potential to be applied on roads cracks or even coat the entire road. This is an ongoing work and has two main sections: 1) To investigate the suitable techniques that will allow identifying the extent of cracks and failures in the roads, and 2) Investigates the suitability of a variety of materials for their application on roads repairs and coating.
In the first section, we will examine the extent of cracks and failures in the roads. It is well known that freezing and thawing cycle is one of the major reason of the development of cracks in the roads. Though the reasons of damage are well investigated, the extent of damage varies on many other factors, such as local geology, road age, etc. In this work, we will utilise the state of the art technologies such as Infrared Imaging, Seismic Refraction, LIDAR, and GPR to determine the extent of cracks and failures in the roads. Obtained information from here will be utilised to devise the repair and coating strategies.
In the second section, we will investigate materials that have appropriate properties. These properties should hold in warmer and colder environments as observed in Arctic. The materials will be tested for their mechanical properties and environmental impact in the labs at UiT The Arctic University of Norway. Further, in this work, we will devise the procedures for repairs. In addition, this work will also bring forward materials that may be coated on the entire surface of the road. The entire coating will bring certain advantages, such as elimination or significant reduction in PM-10 particles and year round ice free surface. Cataloguing tyres interaction with the coated materials and cost-benefit analysis will also be included.

Arctic, Winterization, Roads, Highways, Geophysics, Materials

DYNAMIC MECHANICAL PROPERTY STUDY OF A TYPICAL CFRP LAMINATE UNDER HIGH IMPACT COMPRESSIVE LOADS

WU Wenyou[(a)], LIU Liu[(b)], CHU Yunlin[(a)], PI Aiguo[(a)],
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b. Southern Sichuan Machinery

Because of the outstanding mechanical property, CFRP (Carbon Fiber Reinforced Plastic) material is widely used for high impact load environment. Studies about the mechanical response of CFRP material under impact loads have become hot issues in this field. In this paper, on the basis of bridging model, the dynamic constitutive equations and yield criterion considered about strain rate effect of composite material are used to conduct the optimal design and compressive strength analysis of laminate under high impact compressive loads. Firstly, the compressive strength and stress-strain curve of some laminates under different strain rate are theoretically calculated to compare with the experimental results from relevant literature, and the theoretical results are agreed well with the quasi-static and dynamic compression test results, the improved calculation program is verified and validated. On the basis of this, the comparison among some structure design schemes are analyzed, and a ply scheme satisfied with our requirement is selected. Samples with this ply scheme are manufactured to conduct quasi-static and medium strain rate compressive tests. The previous theoretical calculation results are consistent with experimental results. Since the experiments can only obtain details like the in-plane strain on the surface and the failure mode, the theoretical calculation program is used to discuss the progressive failure phenomenon, and the relevant mechanical characteristic quantities of fiber breakage and matrix damage are also analyzed. This work can be used for the optimization design and property prediction of the CFRP laminate structure under high impact compressive loads.

Carbon fiber; Laminates; Strength; Bridging model

SESSION 2.3

MICROMECHANICS AND MATERIALS

FRIDAY 15 DECEMBER 2017
14:00 – 15:30

CHAIR

H Khawaja
University of Tromsø
Norway

SYNTHESIS AND DENSIFICATION OF HETEROGENEOUS ULTRAFINE AND NANOSTRUCTURED MATERIALS BY HIGH RATE ENERGY PROCESSES: MATERIALS AND DEVICES

Fernand D S Marquis
Department of Mechanical Engineering, San Diego State University, USA

Because the strength, toughness and other engineering properties of heterogeneous materials are strong dependent on their grain size and density, the quest to achieve simultaneously dense and fine, ultrafine and nanostructured grain size materials has been one of the most important in materials science and engineering. In this work we explore novel approaches for producing dense and fine, ultrafine and nanostructured heterogeneous materials. Typical approaches consist of reaction synthesis, combustion synthesis and shock synthesis followed by dynamic and static consolidation and densification pre and post reaction synthesis. Typical heterogeneous materials covered in this paper consist of tungsten heavy alloys, coated graphite powders, metal silicides, aluminides and multiphase, multi microstructural constituent ceramic armor materials. The synthesized and densified materials were fully characterized by OM, SEM, TEM, EDX analysis, quantitative image analysis, X-Ray diffraction and mechanical testing. This paper presents and discusses the effect of reaction and processing parameters on the microstructure, densification and strength and toughness of typical heterogeneous materials. In addition, the presentation will cover device applications.

Shock Synthesis and Densification, Bulk nanostructured and ultrafine materials, intense shock loading

WIDER STRAIN-RATE DEPENDENT DAMAGE CONSTITUTIVE MODEL FOR PBX EXPLOSIVE AND ITS APPLICATION IN PENETRATING CONCRETE TARGET SIMULATIONS

Yanqing Wu
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Polymer-bonded explosives (PBXs) are a family of composite materials formulated with polymeric binder system and hard phase explosive crystals. Damage of PBXs caused by external stimulus influences not only the mechanical properties, but also the sensitivity, combustion and even detonation behavior of energetic materials because cracks, pores or debonding can act as fast reaction channels. The characteristic damage modes present in PBXs include intragranular voids, crystal fractures, and interfacial debonding. A three-dimensional viscoelastic model taking into account above three damage mechanisms has been developed to describe the mechanical response at wide strain rate range (10-3~104 s-1). We can obtain the respective contributions of different damages to mechanical behavior, corresponding to different mechanical stimulus from quasi-static loading to high-strain-rate dynamic conditions. uniaxial compression tests were performed with the loading speed 5 mm/min and 1.0mm/min from 22°C to 75°C on some PBX. The Abaqus user subrountines UMAT and VUMAT were formulated based on the damage-coupled viscoelastic constitutive theory. Experimental quasi-static and dynamic compression data at some loading rates and different temperatures are used to validate the model and calibrate the constitutive parameters.

Multiple damage mechanisms, Interfacial debonding, Intragranular voids, Crystal fractures, Explosive charge

MICROJETTING FROM A GROOVED PB SURFACE UNDER SUPPORTED AND UNSUPPORTED SHOCK CONDITIONS

Jian-Li Shao[a], Pei Wang[b], Cheng Wang[a]

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b. Institute of Applied Physics and Computational Mathematics, Beijing 100094, China;

When strong shockwaves reflect from the metal surface, some matter may be ejected. Up to now, extensive experimental and theoretical works have been conducted on this phenomenon for developing a predictive ejecta model. In this report, we introduce some researches on the microjetting from a shocked Pb surface with MD simulations. Our results reveal the variation laws of micojetting mass and velocity with the shock pressure and profile. With increasing the shock pressure, the microjet mass experiences various stages of increase. When introducing decaying profiles, we observe both the increase and reduction of microjet mass. The ratio of the maximal jetting velocity to the surface velocity is found to keep a constant (1.5-1.55), which will undergo a degree of exponential decaying with time for the solid release cases. In addition, the microjet temperature is always above the melting point (zero pressure). The velocity distribution along the loading direction shows two linear regions corresponding to the microspall and microjet, and the latter seems to have a greater velocity gradient.

Pb, Microjetting, Shock, Molecular Dynamics

HIGH-RATE SQUEEZING PROCESS OF BULK METALLIC GLASSES

Jitang Fan
State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Bulk metallic glasses are quasi-brittle materials with a high hardness, which produces a challenge for the mechanical process.
In this work, high-rate squeezing process of bulk metallic glasses from a cylinder into an intact sheet achieved by impact loading is investigated for developing a state-of-the-art research methodology. Such a large deformation is caused by plastic flow, accompanied with geometrical confinement, shear banding/slipping, thermo softening, melting and joining. Temperature rise during the high-rate squeezing process makes a main effect. The inherent mechanisms are illustrated.
Like high-pressure torsion (HPT), equal channel angular pressing (ECAP) and surface mechanical attrition treatments (SMAT) for refining grain of metals, High-Rate Squeezing (HRS), as a multiple-functions technique, not only creates a new road of processing metallic glasses and other metallic alloys for treating materials, but also directs a novel technology of processing, grain refining, coating, welding and so on for developing advanced materials and structures.

bulk metallic glasses, high strain rate, squeezing

SESSION 2.4

DEVELOPMENTS IN MULTIPHYSICS

FRIDAY 15 DECEMBER 2017
16:00 – 17:30

CHAIR

C Wang
Beijing Institute of Technology
China

EFFECTS OF HEAT LOSS AT WALLS ON FLAME ACCELERATION AND DEFLAGRATION-TO-DETONATION TRANSITION

Han Wenhu
Key Laboratory of Light-Duty Gas-Turbine, Institute of Engineering Thermophysics, Chinese Academy of Sciences, China

This paper studies the effects of heat loss at walls on flame propagation and deflagration-to-detonation transition (DDT) in micro-scale channel by high-resolution simulation. Numerical results show that wall heat loss leads to appearance of oscillating flames. This oscillating flame is attributed to the competition between viscosity and heat loss effects. Moreover, the occurrence of DDT with heat loss depends non-monotonically on the channel width.

Flame, detonation

INVESTIGATION ON MULTI-MEDIUM FLOWS AND EXPLOSIONS BY FINITE DIFFERENCE MOMENT OF FLUID METHOD

Hao Li, Tao Li, Cheng Wang
State Key Lab of Explosion Science and Technology, Beijing Institute of Technology Beijing, China

A finite difference moment of fluid (MOF) method with volume fractions and centroids of only one cell for multi-medium flows was proposed, which is more stable and accurate than Level Set method. Based on the double shockwave approximation procedure, real ghost fluid method (RGFM) and two kinds of tracking methods for moving interfaces - MOF and Level Set, local Riemann problem for strong nonlinear equations of state such as JWL equation of state was constructed. Besides, the numerical problem of the oscillation caused by high-density ratio and high-pressure ratio across the interface was successfully solved. A fifth order Weighted Essentially Non-Oscillatory (WENO) finite difference scheme and the third-order TVD Runge-Kutta method were utilized for spatial discretization and time advance, respectively. Some typical tests such as 2-D rotation of the Zaleasak's disk and 2-D shear flows were used in order to validate the finite difference MOF method. It is found that MOF code is
more effective in capturing the multi-medium interface than Level Set method in these tests, which can keep the interface at critical time as the original shape. After that, the entire process of 2-D air explosion with TNT explosives was successfully simulated by finite difference MOF and high order numerical scheme. Finally, the peak overpressure at critical gauge points were analysed; the results show that the numerical results with MOF and Level Set methods have a good agreement with empirical ones.

MOF; WENO; RGFM; multi-medium flows; explosion

HIGH RESOLUTION SIMULATION OF COAL METHANE HYBRID DETONATION

Xinzhuang Dong[(a)], Cheng Wang[(b)]
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b. State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, China

Coal dust/methane hybrid explosion is a major threat in the process of coal mining. Simulation of the explosion process is of great significance for explosion protection. In the paper, a multi-components two phase reaction dynamics model is established in order to describe the homogeneous chemical reaction and two phase chemical reaction coupling problem. The multi-component gas phase state equation is established, based on the assumption of pressure equilibrium, the solid state equation is established, Mass, momentum and energy exchange model between the two phase is given, the above state equation and exchange model make the two-phase hybrid detonation model to a closed model. The local characteristic decomposition method of multi-component equations is realized, and the finite difference method based on the WENO scheme is constructed. The propagation process of coal dust/methane/air two phase hybrid detonation waves was simulated, and the effect of methane and coal dust concentration on detonation wave propagation characteristics is discussed.

two phase flow, detonation wave, high resolution scheme, numerical simulation

MOTIONAL CHARACTERISTIC OF UNDERWATER EXPLOSION BUBBLE NEAR CIRCULAR HOLE OF SOLID WALL

Jian Xue, Cheng Wang
State Key Lab of Explosion Science and Technology, Beijing Institute of Technology, China

A hole can be formed after the warship is attacked by underwater explosion, which has great significance on the secondary damage to structures. In this paper, the phase of bubble jet near circular hole was simulated by Autodyn; effects of different parameters - horizontal and vertical distance - were investigated. Define dimensionless parameter γ_f is the horizontal distance between explosive and solid wall/maximum radius of expanding bubble and γ_h is the vertical distance between explosive and center of hole/ maximum radius of expanding bubble. Three cases were discussed - $0.2 < \gamma_f < 1.3$, $1.3 < \gamma_f < 2.2$ and $\gamma_f > 3$. It is found that before the bubble was penetrated in the case with $0.2 < \gamma_f < 1.3$ and $1.3 < \gamma_f < 2.2$ the jets were formed in the opposite and positive directions of the wall, respectively, while the bubble jet could not be formed in the case with $\gamma_f > 3$. The pressure distribution along the wall was nonlinear. The pressure on the wall peaked at $\gamma_h = 1.3$ since the jet impacted the wall while it would not affect the movement of the bubble at $\gamma_h > 2.7$. After that, parameters - the jet velocity, pressure, pulsation period and center displacement - were analysed. The results show that the decrease of the hole radius was of great benefit to the jet formation in the opposite direction of the wall. In addition, the comparison results show that the peak pressure, velocity and pulsation period in case with hole were lower than that without hole.

underwater explosion, bubble, jet, solid wall, Autodyn

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