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Message from the Chair

As I look out at the first signs of snow on the mountaintops of Northern New Mexico, I am reminded that we are in a season of change. Fall brings a new school year, a new fiscal year, a National election, and a looking forward to 2013. In October, many in our community gathered in Chicago to celebrate the 10th anniversary of the dedicated high pressure beamline (HPCAT) at the Advanced Photon Source and to look forward to the next 10 years of static-to-dynamic compression science at the APS. We are in an exciting era for dynamic compression science, with a broad National and International interest in materials in extreme conditions and a number of new facilities, from LCLS at Stanford to ECB at PETRA-II to DCS @ APS, bringing renewed focus on interrogating the physics of materials under the thermomechanical “extremes” of high pressure, temperature and high strain rate environments.

Within the Topical Group, we are also looking forward to the future. We are in the midst of elections of officers for the executive committee, and this Fall many of our members are serving on the 2013 Joint APS SCCM/AIRAPT conference organizing committee, which has been busy planning next summer’s conference in Seattle (July 7-12, 2013). I am excited by the enthusiasm and energy associated with our Topical Group’s upcoming meeting. The organizing committee has joined the SCCM and AIRAPT communities in planning special

sessions and plenary and invited talks. Scott Alexander (Sandia National Laboratory) is a new leader of the student programs for the meeting, which will include a Sunday student symposium for the first time. Please check the meeting website for student scholarship information as well. Dawn Flicker (Sandia National Laboratory) will be leading outreach activities, which will include a competitive sponsorship of a featured speaker from an unrepresented group or country (call to be issued soon). You will also notice the new format of our group’s newsletter led by Eric Chisolm and Darcie Koller (both of Los Alamos National Laboratory). Many of these new directions have stemmed from your feedback and engagement at the annual business meetings, and from help from the APS National Office team.

We have also just announced our Topical Group’s new APS fellows, William (Bill) Anderson of LANL and Neil Bourne of AWE, and the recipient of the 2012 George E. Duvall Shock Compression Science Award, Gennady Kanel. Gennady will accept the award at this summer’s meeting and deliver a plenary presentation on his work. I hope you will join me in congratulating Bill, Neil, and Gennady on the substance of their science, and their dedication to the field of shock compression.

See you in Seattle,

Dana Dattelbaum

Technical Highlight

Numerical and experimental studies of blunt impacts to the eye

Numerical simulation is a common tool to investigate the performance of materials and structures in many science and technology fields. Although this approach is commonly used in biomechanics, there remain many areas in medicine where it can be used to understand mechanisms that may cause damage and injury.

The Machine Design Research Group (MDRG) at the University of Cassino, Italy, has developed a scientific collaboration with the Ophthalmic Hospital of Rome to understand the pathogenesis of the retina when a human eye is subjected to an insult caused by an impact or blast load, focusing the attention on the potential key role of shock wave interaction phenomena.

Ocular traumas are the second leading cause of visual impairment in the United States. Over 60% of the 2.4 million ocular lesions yearly estimated in the U.S. alone are due to blunt trauma, an impact with an object without penetrating the eye wall. Eye injuries are also relatively common following detonations. Explosions have the potential to inflict complex and unique patterns of injury: primary injuries due only to exposure to the overpressure of the blast wave resulting in non-penetrating trauma, and secondary injuries due to fragments resulting in blunt and penetrating trauma. Blunt trauma can cause the retina to tear or detach from its underlying surface. Possible explanations of blunt trauma retinal injury mechanisms reside in the deformation of the ocular globe, the traction exerted by the vitreous (vitreous pull-traction) and the differential elasticity of the various ocular structures. The most popular theory, accepted among ophthalmologists, is the equatorial expansion theory (EET). According to this, damage at the retina and other internal structures is caused by the stress generated by the equatorial expansion of the eye bulb and sustained by the inertia of the vitreous.

Recently, the Ophthalmic Hospital of Rome found compelling evidence from clinical cases that this mechanism is not necessarily the main one responsible for retina damage. A 54-year-old white male was diagnosed with

tearing of the retina after being inadvertently shot by a BB pellet gun in his right eye, although the vitreous had been removed three years earlier by primary *pars plana* vitrectomy. Similarly, retinal damage without sign of secondary injuries was observed in a 28-year-old white male who was injured by an explosion while manufacturing a homemade firecracker.

To study these cases, a computational finite element model of the human eye was developed. The model was based on dimensions of an average adult human eye. All the major structures of the eye (cornea, sclera, retina, crystalline lens, aqueous and vitreous) were simulated at the continuum scale using Lagrangian solid elements (Figure 1). Since experimental data for selecting and validating appropriate eye tissues' constitutive behavior are limited and have large scatter, the simplest constitutive laws able to reproduce a given critical experiment were selected. Model parameters were identified using the reverse engineering approach of the blunt impact experiment described by Delori et al. [1] who measured the time resolved deformation response of human eye impacted by a BB pellet as well as the residual velocity of the projectile, Figure 2.

The major finding is that, according to our computational eye model (CEM), the macular region is the most critical location where tensile pressure is strong enough to detach and tear the retina. The characteristic time for

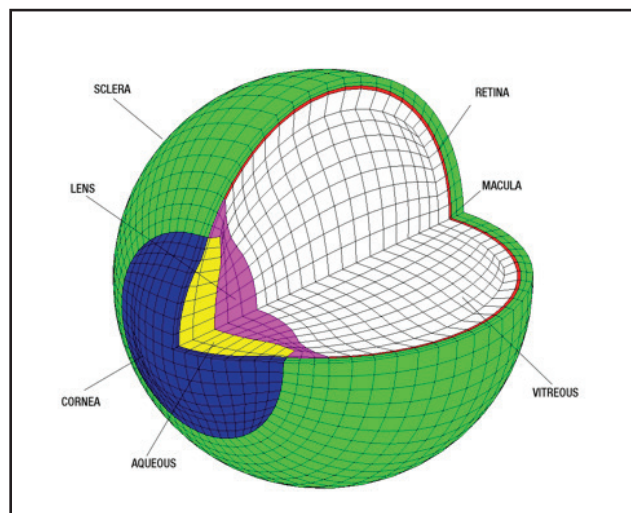


Figure 1 – Computational Eye Model

such a process, which is the result of stress wave propagation and reflection, is of the order of 0.05 ms, which is at least ten times smaller than the time necessary for the eye to start to deform equatorially (EET) [2]. When the eye is exposed to blast load, it was found that 65 g of TNT detonating at 50 cm, as for the reported clinical case, generates the same tensile pressure at the macula as found in the blunt impact experiment.

The study was extended to account for the environment surrounding the eye. The orbital fat, the orbit and the skull bone were included in the model. In this case, the presence of the pseudo-conical cavity which hosts the

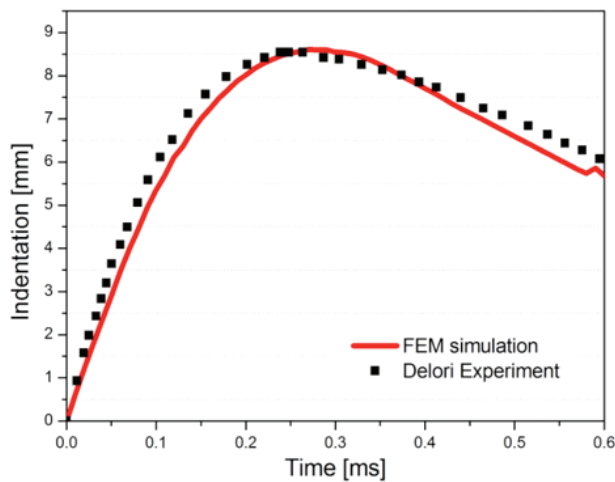


Figure 2 - Comparison of the calculated and measured eye indentation vs time

eye, as a result of different mechanical impedances, can amplify the pressure generated in the area near the macula where retinal damage more often is found to occur [3]. In support of the computational model and to validate the results, two types of experiments have been designed. In the first, a simply supported eye is impacted frontally by a BB pellet shot by a gas gun at controlled impact velocity. The eye is instrumented by a pressure sensor surgically attached at the rear of the eyeball. Tests were performed on *in vitro* pig and human eyes. In addition a surrogate eye, made of ballistic gel, was also used to measure the indentation of the pellet during the impact, Figure 3. The second type of experiment measures the pressure generated at the macular region as a result of blast load. In this case, pressure load was generated using a 40 mm bore gas gun with a tailoring wave device developed at the Naval

Surface Warfare Center [4] which reproduces triangular waves, avoiding the need for explosives.

The laboratory where this work was performed was started at the University of Cassino in 1997 as a result of the collaboration between the Machine Design Research Group (MDRG) and AFRL/EOARD in the field of damage mechanics and failure modeling of materials. Today, the laboratory has computational and experimental capabilities that include material testing at high strain rates (direct tension Hopkinson bar up to 150 kN); and impact testing with single stage light gas gun (several calibers up to 300 bar pressure) and firearms allowing a wide number of test types (V50, NAG qualification, Taylor impact, Rod-on-Rod, dynamic tensile extrusion test, etc.). The activity of the MDRG is currently focused on consolidating a procedure for the measurement of the dynamic fracture toughness with the Hopkinson bar and modeling fragmentation and dynamic damage processes in metals and alloys. The MDRG participates in the GSCCM and promotes the presence of the APS in other international scientific events, such as the European Conference of Composite Materials (ECCM2012) held in Venice this



Figure 3 – Blunt impact on surrogate eye

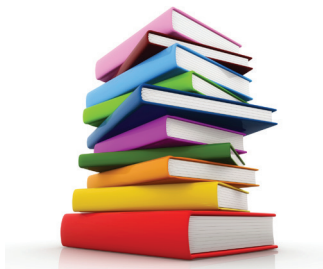
year. The MDRG members are Nicola Bonora, Domenico Gentile, Andrew Ruggiero, Luca Esposito, Gianluca Iannitti, Gabriel Testa, Simone Dichiaro and Chiara Clemente.

Contributed by Nicola Bonora, University of Cassino

References

1. F. Delori, O. Pomerantzeff, and M. D. Cox, 1969, "Deformation of the Globe under High Speed Impact: Its Relation to Contusion Injuries," *Investigative Ophthalmology*, 8 (3), pp. 290-301.
2. T. Rossi, B. Boccassini, L. Esposito, M. Iossa, A. Ruggiero, C. Tamburrelli, and N. Bonora, 2011, "The Pathogenesis of Retinal Damage in Blunt Eye Trauma: Finite Element Modeling," *Investigative Ophthalmology and Visual Science*, 52 (7), pp. 3994-4002.
3. T. Rossi, B. Boccassini, L. Esposito, C. Clemente, M. Iossa, L. Placentino, and N. Bonora, 2012, "Primary Blast Injury to the Eye and Orbit: Finite Element Modeling " *Investigative Ophthalmology and Visual Science* (IOVS-12-10591), pp. 1-15.
4. S. Bartyczak and W. Mock Jr., 2011, "Versatile Gas Gun Target Assembly for Studying Blast Wave Mitigation in Materials," *Shock Compression of Condensed Matter-2011*, AIP Conf. Proc. 1426 (Melville, NY), pp. 501-504.

Bookshelf



Adiabatic Shear Localization: Frontiers and Advances 2nd ed

Ed by B. Dodd and Y. Bai
Elsevier
ISBN 0080977812

Brittle matrix composites 10

Ed by A. M. Brandt, M. A. Glincki, J. Olek, and C. K. Y. Leung
Woodhead Publishing Ltd.
ISBN 0857099884

Dynamic Behavior of Materials, Volume 1

Ed by T. Proulx
Springer
ISBN 9781461402152

Fracture and Life

B. Cotterell
Imperial College Press
ISBN 1848162820

Iron and Steel

W. F. Hosford
Cambridge University Press
ISBN 9781107017986

Metal-Fluorocarbon Based Energetic Materials

E.-C. Koch
Wiley-VCH
ISBN 9783527329205

Performance, Protection and Strengthening of Structures under Extreme Loading

Applied Mechanics and Materials, Volume 82
Ed by E. Cadoni and M. di Prisco
Wiley-VCH
ISBN 9783037852170

Terminal Ballistics

Z. Rosenberg and E. Dekel
Springer
ISBN 9783642253041

The Virtual Fields Method: Extracting Constitutive Mechanical Parameters from Full-field Deformation Measurements

Ed by F. Pierron and M. Grédiac
Springer
ISBN 9781461418238

2013 George E. Duvall Award

The 2013 George E. Duvall Award will be presented to Gennady I. Kanel, Institute for High Temperatures, Russian Academy of Sciences.

“For outstanding contribution to the physics of shock waves in condensed matter, discovery and studying anomalous thermal hardening, superheated solid states, failure wave phenomena, and investigations of sub-microsecond strength properties of materials over a wide range of load durations and temperatures.”

Gennady I. Kanel graduated from Tomsk State University, USSR, in 1967. After the University, he worked in the Institute of Problems of Chemical Physics of the Russian Academy of Sciences (Chernogolovka) until 1988 as a Junior Science Worker, Senior Science Worker, and Chief Scientist. In 1988 he joined the Joint Institute for High Temperatures RAS (Moscow) and has been here as a head of laboratory, head of department, and now as a deputy director. He got the degree of candidate of physical and mathematical sciences in 1972, the degree of doctor of physical and mathematical sciences in 1987, the title of professor in 1996, and was elected to Russian Academy of Sciences as a corresponding member in 2006. His research work is focused on understanding the fundamental mechanisms and evaluating the kinetics of inelastic deformation, fracture, structural transformations in solids and energy release in high explosives under shock-wave loading. He is a member or ex-member of the American Physical Society, Russian National Committee on Theoretical and Applied Mechanics, Executive Committee of International



Gennady I. Kanel

Society of High Pressure Physics and Technology (AIRAPT), and Executive Committee of European High Pressure Research Group. Kanel was awarded the USSR State Prize in 1988 and the “Order of Services for the Fatherland” in 2005.

Selection Committee:

Gilbert Collins, Chair; J.N. Johnson; G. Gray; N. Thadhani; J. Eggert

News and Events

Topical Group Officer Elections

Please remember to VOTE in our Officer Elections. For the next 2 - 4 years, the Officers will be making decisions about Committee memberships, Conference leadership, Bylaws changes, our participation in the March meetings, outreach efforts, policies for Award endowments, Topical Group scope, website changes, and other matters, as well as interacting with APS on various topics. All Topical Group members should have received an email or letter from APS with voting instructions; if you did not receive

either, please contact Election Registrar Mike Furnish at mdfurni@sandia.gov. The link in the email allows you to access candidate biographies and statements. The election closes on December 18.

The 2012 officers are listed on the TG website, <http://www.shockphysics.org/pages/officers.html>. Many thanks to the outgoing officers for their service to the TG: Members-at-Large Ellen Cerreta and Dan Eakins, Secretary-Treasurer Michael Furnish, and Past Chair Neil Bourne.

Travel Rules and our Biennial Conferences

The new DOE travel restrictions are a concern to many members of our Topical Group, and may have a significant effect on our biennial conferences as well as the

March Meeting and DPP meetings. See the article by Mike Lubell, APS Director of Public Affairs, at http://www.rollcall.com/news/lubell_reject_travel_rules_that_stifle_science-219305-1.html, also linked prominently from the APS home page.

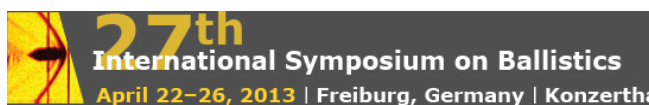
Upcoming Meetings



The APS March Meeting will be held March 18-22, 2013, in Baltimore. GSCCM is organizing the focus topic “Materials in Extremes: Bridging Simulations and Experiment” together with DCOMP and DMP.

For more information on the March Meeting, see <http://www.aps.org/meetings/march>; a description of the focus topic may be found at <http://www.aps.org/meetings/march/scientific/focus3.cfm#16.1.8>. Post-deadline abstracts are accepted until December 21, 2012.

The 2013 MRS Spring Meeting and Exhibit will be held April 1-5, 2013, in San Francisco. The abstract submission deadline is past, but attendance information is still available at <http://www.mrs.org/spring2013>.



registration and hotel reservations are still open at www.ballisticsymposium2013.org. Please see the website <http://www.ballisticsymposium2013.org/> for further details, including the technical program.

The 27th International Symposium on Ballistics will be held April 22-26, 2013, at the Konzerthaus Freiburg, Germany. The deadline for submitting presentations is past, but registration and hotel reservations are still open at www.ballisticsymposium2013.org. Please see the website <http://www.ballisticsymposium2013.org/> for further details, including the technical program.



The **Joint AIRAPT / APS SCCM 2013 Conference** will be held July 7-12, 2013, in Seattle. This is a unique opportunity for members of GSCCM to interact with our static high-pressure colleagues. There are also many opportunities for students, postdocs, and early career researchers to participate. Everything you could ever want to know about

the conference may be found at <http://www.apssccm-airapt24.org/>.

The **IUTAM Symposium on Recent Development of Experimental Techniques Under Impact Loading** will be held May 6-10, 2013, at the Northwestern Polytechnical University, Xi'an, China. The deadline for abstract submission is December 22, 2012. For more information, contact the conference secretary at iutam_itms2013@nwpu.edu.cn.



The **13th International Conference on Fracture** will be held June 16-21, 2013, in Beijing. The abstract deadline has passed,

but registration and information about the conference are available at <http://www.icf13.org>.

MULTIMAT 2013, the 2013 Multimaterial Hydrodynamics Conference, will be held September 2-6, 2013, in San Francisco. This conference focuses on numerical methods relevant to multi-material hydrodynamic simulations. Conference information is available at <https://multimat13.llnl.gov>, and note that hotel rooms are expected to go fast because the America's Cup takes place the following week.



Various upcoming meetings are listed on the site of the **Minerals, Metals and Materials Society**, <http://www.tms.org/>.

Information on all the upcoming **Gordon Research Conferences** (and there are a lot) may be found at <http://www.grc.org/meetings.aspx>.



The latest issue of *APS News* is always available online at <http://www.aps.org/publications/apsnews/>. In particular, the Education Corner department carries information about various scholarships and other programs offered by APS mainly in support of undergraduate physics students.



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Please send any questions or comments about the newsletter to any of the editors.

Special thanks to Kerry Johnson and Nancy Bennett-Karasik of APS Special Publications.

The APS Topical Group on Shock Compression of Condensed Matter (GSCCM) was founded in 1984 to promote the development and exchange of information on the dynamic high-pressure properties of materials. The Topical Group sponsors biennial technical meetings on shock compression and detonation physics research, including experimental, theoretical and computational studies, and new experimental methods and developments