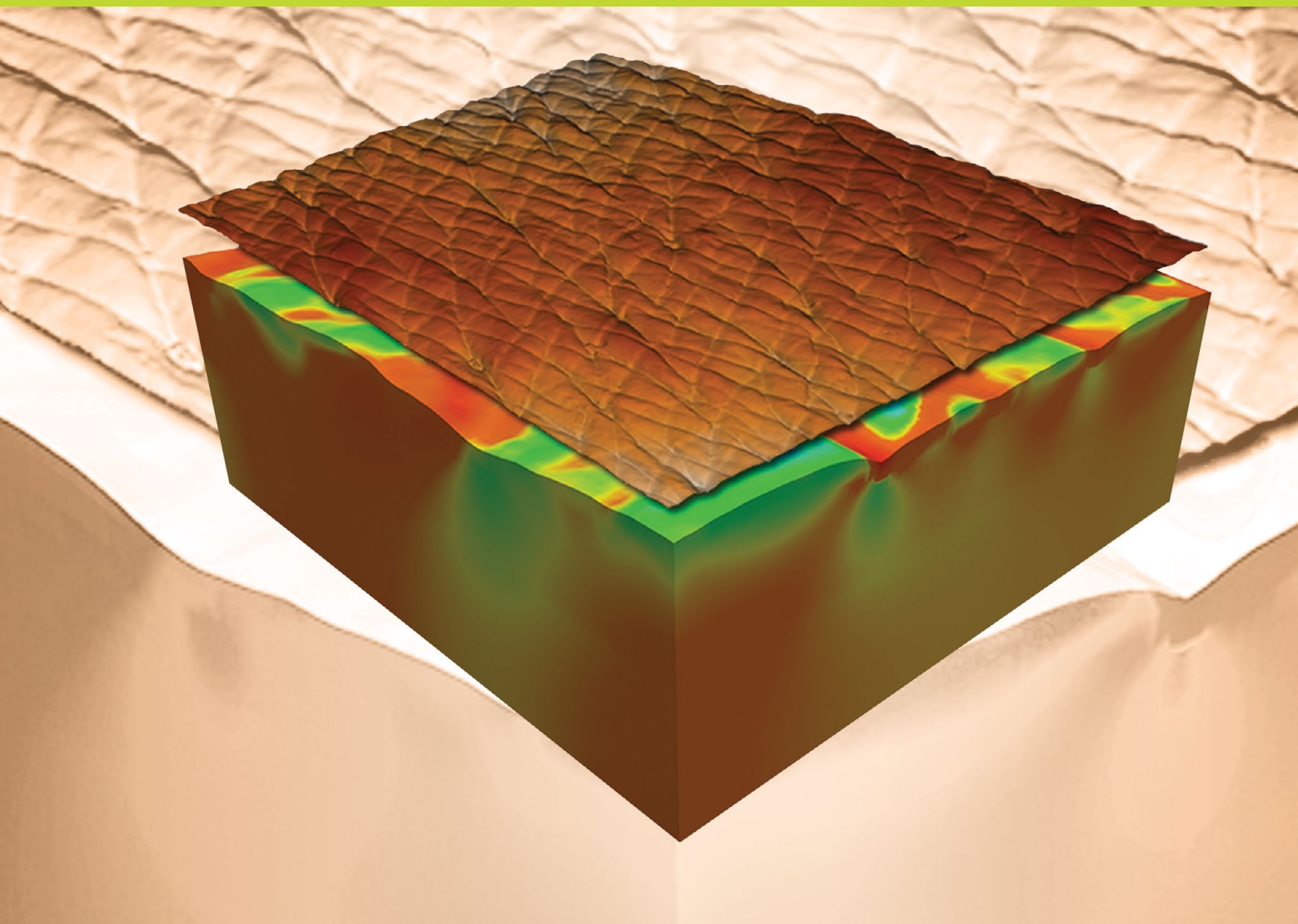


RECENT ADVANCES IN THE TRIBOLOGY AND BIOENGINEERING OF THE SKIN

Institution of
**MECHANICAL
ENGINEERS**

25 November 2014
One Birdcage Walk, London
www.imeche.org/events/S6128

Tribology Group and Biomedical
Division
Seminar



RECENT ADVANCES IN THE TRIBOLOGY AND BIOENGINEERING OF THE SKIN

25 November 2014, One Birdcage Walk, London



RECENT ADVANCES IN THE TRIBOLOGY AND BIOENGINEERING OF THE SKIN WILL PRESENT CUTTING EDGE SOLUTIONS AND RADICAL NEW THINKING THAT CHARACTERISE AND PREDICT THE BIOPHYSICS OF THE SKIN IN HEALTH AND DISEASE.

This seminar will explore modelling techniques for biotribology, including the latest advanced computational models for skin biophysics. The principal goal is to explore how they are developed and can be implemented in commercial, finite element codes to accelerate product development.

BENEFITS OF ATTENDANCE:

- **Analyse** how modelling techniques are used to elucidate the complex mechanics of the skin with Dr. Georges Limbert
- **Understand** how microclimate factors influence the integrity of the loaded skin interface with Prof. Dan Bader
- **Learn** how to tackle current challenges in healthcare and personal care device development with Dr. Steve Franklin
- **Study** the prospects of consultant engineers in the high-growth 'engineering for life sciences' market

AGENDA SNAPSHOT:

(For the full programme, see page 2)

- Predictive modelling of the static and dynamic friction behaviour of human skin
- Biotribology: challenges in healthcare and personal care device development
- Evaluation of the impact of sun exposure on the skin barrier using a biomechanics framework
- Mechanical properties of the top-layers of human skin

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TUESDAY 25 NOVEMBER 2014

- 08:30 REGISTRATION AND REFRESHMENTS**
- 09:00 CHAIR'S WELCOME**
Dr. Georges Limbert, National Centre for Advanced Tribology, University of Southampton
- 09:10 PREDICTIVE MODELLING OF THE STATIC AND DYNAMIC FRICTION BEHAVIOUR OF HUMAN SKIN**
Dr. Marc Masen, Department of Mechanical Engineering, Imperial College
- Friction and the prevention of Decubitus Ulcers
 - Modelling and measuring friction of the human skin
 - Relation contact, friction and experience
- 09:35 UNDERSTANDING THE GENERIC INFLUENCE OF MOISTURE ON THE FRICTION OF SKIN FROM THE CONTACT MECHANICS OF THE FINGER PAD**
Prof. Michael Adams, School of Chemical Engineering, University of Birmingham
- Influence of secreted sweat on the friction of the finger pad
 - A kinetic description of the changes in the contact mechanics
 - Role of hydrophobicity, roughness and permeability of contacting surfaces
- 10:00 A COMPARISON OF THE TRIBOLOGICAL BEHAVIOUR OF EX-VIVO HUMAN, TISSUE-ENGINEERED AND SYNTHETIC SKIN**
Prof. Roger Lewis and Dr. Matt Carré, Department of Mechanical Engineering, University of Sheffield
- A comparison of friction behaviour
 - Understanding the effects of moisture
 - Characterising tissue damage
- 10:25 Q&A SESSION**
- 10:40 NETWORKING REFRESHMENT BREAK**
- 11:10 BIOTRIBOLOGY: CHALLENGES IN HEALTHCARE AND PERSONAL CARE DEVICE DEVELOPMENT**
Dr. Steve Franklin, Chief Technologist, Tribology & Human Tissue Interaction, Philips Research
- How does biotribology influence applications in healthcare and personal care?
 - What are the biotribology challenges in relation to device development?
- 11:35 SKIN DEEP IN MODELLING: FROM WRINKLES TO BIOMIMETIC SURFACES**
Dr. Georges Limbert, National Centre for Advanced Tribology, University of Southampton
- How modelling techniques are used to elucidate the complex mechanics of skin
 - Interplay between material and structural properties
 - The physics of skin wrinkles: understanding and exploitation
- 12:00 Q&A SESSION**
- 12:10 NETWORKING LUNCH**
- 13:10 EVALUATING THE IMPACT OF SUN EXPOSURE ON THE SKIN BARRIER USING A BIOMECHANICS FRAMEWORK**
Dr. Kemal Levi, Founder, Bio-X Consulting
- How does the stress state of skin and its mechanical properties change with sun exposure?
 - Measuring the propensity for sun-induced skin damage and the efficacy of sun protection strategies in alleviating this damage

- 13:35** **HOW MICROCLIMATE FACTORS INFLUENCE THE INTEGRITY OF THE LOADED SKIN INTERFACE**
Prof. Dan Bader, Faculty of Health Sciences, University of Southampton
- The effects of temperature and humidity of the metabolism of loaded skin
 - Model systems to monitor temperature and humidity
 - Bioengineering strategies to prevent mechanical-induced skin breakdown
- 14:00** **EXPLOITING INHERENT PROPERTIES OF DERMAL PAPILLA CELLS TO ENGINEER A HAIR FOLLICLE**
Dr. Claire Higgins, Department of Bioengineering, Imperial College
- Epithelial: mesenchymal interactions in the follicle
 - The concept of follicle neogenesis
 - Artificial skins
- 14:25** **Q&A SESSION**
- 14:40** **NETWORKING REFRESHMENT BREAK**
- 15:10** **INVERSE METHOD TO ASSESS IN VIVO THE MECHANICAL PROPERTIES OF THE SKIN LAYERS**
Dr. Roberto Santoprete, Senior Research Engineer, L'Oréal Research and Innovation
- Approach coupling of three experimental devices with a multi-layer biomechanical model of the skin
 - Application to study the effect of a moisturiser
 - Application to study the effect of ageing
- 15:35** **MECHANICAL PROPERTIES OF THE TOP-LAYERS OF HUMAN SKIN**
Dr. Cees Oomens, Associate Professor in Biomechanics and Continuum Mechanics, Eindhoven University of Technology
- An overview of a series of indentation and shear tests on isolated stratum corneum, epidermis and dermis
 - A new method to measure in-vitro local shear properties of skin using inverse methods
 - A first proposal for a non-linear, visco-elastic constitutive model for the top-layers of skin
- 16:00** **MEASURING MECHANICAL PROPERTIES OF THE SKIN**
Prof. Sam Evans, Deputy Director, Institute of Mechanical and Manufacturing Engineering, Cardiff University
- 16:25** **Q&A SESSION**
- 16:40** **CHAIR'S CLOSING COMMENTS**
Dr. Georges Limbert, National Centre for Advanced Tribology, University of Southampton
- 17:00** **END OF SEMINAR**

Find out more about our speakers at www.imeche.org/events/S6128

- This programme is subject to change.
- The Institution is not responsible for the views or opinions expressed by individual speakers.

With thanks to:

Dr. Georges Limbert, National Centre for Advanced Tribology, University of Southampton

SPEAKERS AND CONTRIBUTORS



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**- The Biomedical Engineering
Association (BmEA)**

**DR. GEORGES LIMBERT CHAIR
NATIONAL CENTRE FOR ADVANCED TRIBOLOGY, UNIVERSITY OF
SOUTHAMPTON**

Georges Limbert joined nCATS as an Assistant Professor in Mathematical Modelling in Biotribology in 2009. His current research focuses on the modelling of skin biophysics, the continuum mechanics of biological soft tissue structures and biomaterials and novel computational techniques for thin structures. Georges has expertise in non-linear continuum/computational mechanics and the formulation of constitutive models for biomaterials, biological tissues and structures. He is a Chartered Engineer and Fellow of the Institution of Mechanical Engineers, sits on the board of the Engineering in Medicine and Health Division of the Institution (since 2004) and chairs the Technical Activity Committee on Skin that he established in 2012.

**DR. STEVE FRANKLIN
CHIEF TECHNOLOGIST, TRIBOLOGY & HUMAN TISSUE
INTERACTION, PHILIPS RESEARCH**

Steve Franklin joined Philips Electronics in 1986, starting his career working on coatings and surface treatments, tribology, lifetime performance and reliability, biotribology and device-human tissue interactions. He initially achieved a BSc 1st Class Hons. in Applied Physics and Materials Science from Sheffield Hallam University, followed by a PhD in Metallurgy at Loughborough University. Steve is also a visiting Industrial Professor in Tribology/Biotribology/Human Tissue Interaction at the University of Sheffield.

**DR. CLAIRE HIGGINS
DEPARTMENT OF BIOENGINEERING, IMPERIAL COLLEGE**

Claire Higgins received a PhD in Skin Developmental Biology from Durham University in 2007. She then moved to the Department of Dermatology at Columbia University in New York for postdoctoral training before joining the Department of Bioengineering at Imperial as a Lecturer in April this year. As a postdoc, she received a Career Development Award from the Dermatology Foundation to research the 'Molecular Basis of Human Hair Follicle Induction.' At Imperial, the main focus of the research group is to understand mechanisms of skin and hair development and regeneration, both during homeostasis and in response to disease or injury.

**DR. CEES OOMENS
ASSOCIATE PROFESSOR IN BIOMECHANICS AND CONTINUUM
MECHANICS, EINDHOVEN UNIVERSITY OF TECHNOLOGY**

Cees Oomens is Associate Professor in Biomechanics and Continuum Mechanics. He studied Physics at Eindhoven University of Technology and obtained his PhD at the University of Twente, studying the mechanical behaviour of skin. Currently his research is focused on damage and adaptation of soft biological tissues. A major application field is the study on the aetiology of pressure ulcers. The goals are to develop an objective method to identify patients at risk of developing a pressure ulcer and to develop techniques for early detection of deep tissue injury. He is the first author of the text book 'Biomechanics: Concepts and Computation.'

**DR. ROBERTO SANTOPRETE
SENIOR RESEARCH ENGINEER, L'ORÉAL RESEARCH & INNOVATION**

Roberto Santoprete has a PhD in semiconductor physics and since 2005 has been in charge of the development of multi-physics modelling approaches to help design new cosmetic treatments for skin and hair. Roberto currently works for the Physics Department at L'Oréal Research & Innovation.

**PROFESSOR SAM EVANS
DEPUTY DIRECTOR, INSTITUTE OF MECHANICAL AND
MANUFACTURING ENGINEERING, CARDIFF UNIVERSITY**

Sam Evans joined the Cardiff School of Engineering in 1996 from the University of Southampton. His particular interests lie in biomaterials and nanocomposites, specifically the fatigue of biomaterials such as bone cement and aerospace materials, the use of acoustic emission and ultrasound techniques to detect damage, and computational modelling using finite element and boundary element models. Further interests include the use of digital image correlation techniques to measure strain distribution in bones, skin, implants and aerospace components, and the development of constitutive models and new implicit solution algorithms for skin and soft tissues.

SPEAKERS AND CONTRIBUTORS



THE AIM OF THE BIOMEDICAL ENGINEERING ASSOCIATION IS TO BRING TOGETHER KEY WORKERS FROM BOTH MEDICINE AND ENGINEERING TO DISCUSS THE LATEST ADVANCES AND ISSUES, TO ENABLE NETWORKING AMONG DIFFERENT INDUSTRY LEADERS, AND TO PROMOTE THIS GROWING FIELD TO GOVERNMENT, HEALTHCARE PROFESSIONALS AND THE WIDER PUBLIC.

- The Biomedical Engineering Association (BmEA)

PROFESSOR ROGER LEWIS

DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF SHEFFIELD

Roger Lewis heads a group investigating a wide range of industrial tribological issues. One of his main themes is human tribology, including skin friction, damage and medical device interactions with human tissue, but also including teeth cleaning and leg waxing.

DR. MATT CARRÉ

DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF SHEFFIELD

Matt Carré leads a group working closely on the area of skin tribology, initially carrying out investigations through an undergraduate project on rugby ball handling performance. This has since led to the completion of four PhD studies and numerous papers on the fundamental understanding of the effects of surface roughness, moisture and loading on skin tribology, as well as a range of medical and consumer applications. They are currently working on a major EPSRC project to link OCT (Optical Coherence Tomography) measurements with human skin behaviour, as well as the UNITISS Marie Curie project with Philips on catheterisation.

PROFESSOR MICHAEL ADAMS

SCHOOL OF CHEMICAL ENGINEERING, UNIVERSITY OF BIRMINGHAM

Michael Adams has published over 170 scientific papers, book reviews, book chapters on particle technology, as well as co-editing four books on Tribology in Particulate Technology, Theoretical and Computational Methods in Tribology, Solid-Solid Interactions and Dynamics of Complex Fluids. He has co-ordinated major grants from the TSB and the EU including a current FP7 project. As an academic lead for the Science City Research Alliance, he is responsible for a laboratory that has specialist facilities to study advanced materials and biomaterials.

DR. MARC MASEN

DEPARTMENT OF MECHANICAL ENGINEERING, IMPERIAL COLLEGE

Marc Masen received his MSc and PhD degrees in Mechanical Engineering from the University of Twente. He joined Imperial College as a Senior Lecturer in 2013. Marc's main areas of research are Tribology of Human Tissue and Wear Mechanisms. Recent work includes the development of analytical models for the contact and friction behaviour of compliant, visco-elastic materials, an investigation of the wear behaviour of UHMWPE for use in implants and the design of a novel portable tribometer that has been used in the development of a statistics-based model for friction forces in human skin contacts.

PROFESSOR DAN BADER

FACULTY OF HEALTH SCIENCES, UNIVERSITY OF SOUTHAMPTON

Dan Bader studied Physics at Liverpool University, followed by an MSc in Medical Physics and a PhD at Southampton University. He later moved to Queen Mary, University of London (QMUL) as a lecturer in biomaterials and was one of the core research staff in the IRC in Biomedical Materials. In 1999, he was appointed Professor of Medical Engineering in the Department of Engineering (QMUL). In 2011, he joined the Faculty of Health Sciences at the University of Southampton, where his multidisciplinary team is establishing bioengineering strategies to maintain skin health. He has published over 180 refereed scientific papers and edited three books.

DR. KEMAL LEVI

FOUNDER, BIO-X CONSULTING

Kemal Levi is a researcher, entrepreneur and scientific consultant for medical devices and biotechnology industries. He is the founder of Bio-X Consulting, a technology and consulting firm that partners with clients in technology innovation and development. He has authored numerous patents and publications in his field and is a frequent speaker on skin mechanics and reliability. Kemal received his doctorate in Materials Science and Engineering from Stanford University.

BOOKING FORM

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RECENT ADVANCES IN THE TRIBOLOGY AND BIOENGINEERING OF THE SKIN

25 November 2014
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