CCC-30

30 Years of Composites and Coatings in Cambridge

Friday 25th August, 2017

The Gordon Laboratory

CCC-30

This Symposium will take place in Downing College, Cambridge (below), on 25th August, 2017. The organising committee is composed of Bill Clyne, James Dean, Jin-Chong Tan and Amaia Cipitria. The website is at http://www.ccg.msm.cam.ac.uk/initiatives/ccc-30.

Symposium Coverage

The Symposium will, very broadly, survey the work done over the past 30 years in the Composites and Coatings group. The group has been based in the Cambridge Materials Science Department since its formation in 1985, forming part of the Gordon Laboratory from its creation in 1999. There will be 18 talks, all of 15 minutes duration, covering a range of topics. These will relate to both past and current research work in the group, but will also cover various activities undertaken by alumni since they left the group.

Format and Attendance

A total of 48 delegates will be attending, all current or past members of the group, including PhD students (of which there have been about 80), post-doctoral fellows and visiting scientists who spent extended periods with the group. The meeting will be the latest in a long line of social/scientific gatherings, which have included events such as ski symposia in Villars (right). The talks will be presented in the Howard Lecture Theatre, where lunch and refreshments will also be provided. There will be a Symposium dinner in the Hall on the evening of the meeting. There will also be some social activities on the following day (Saturday 26th August).

Programme

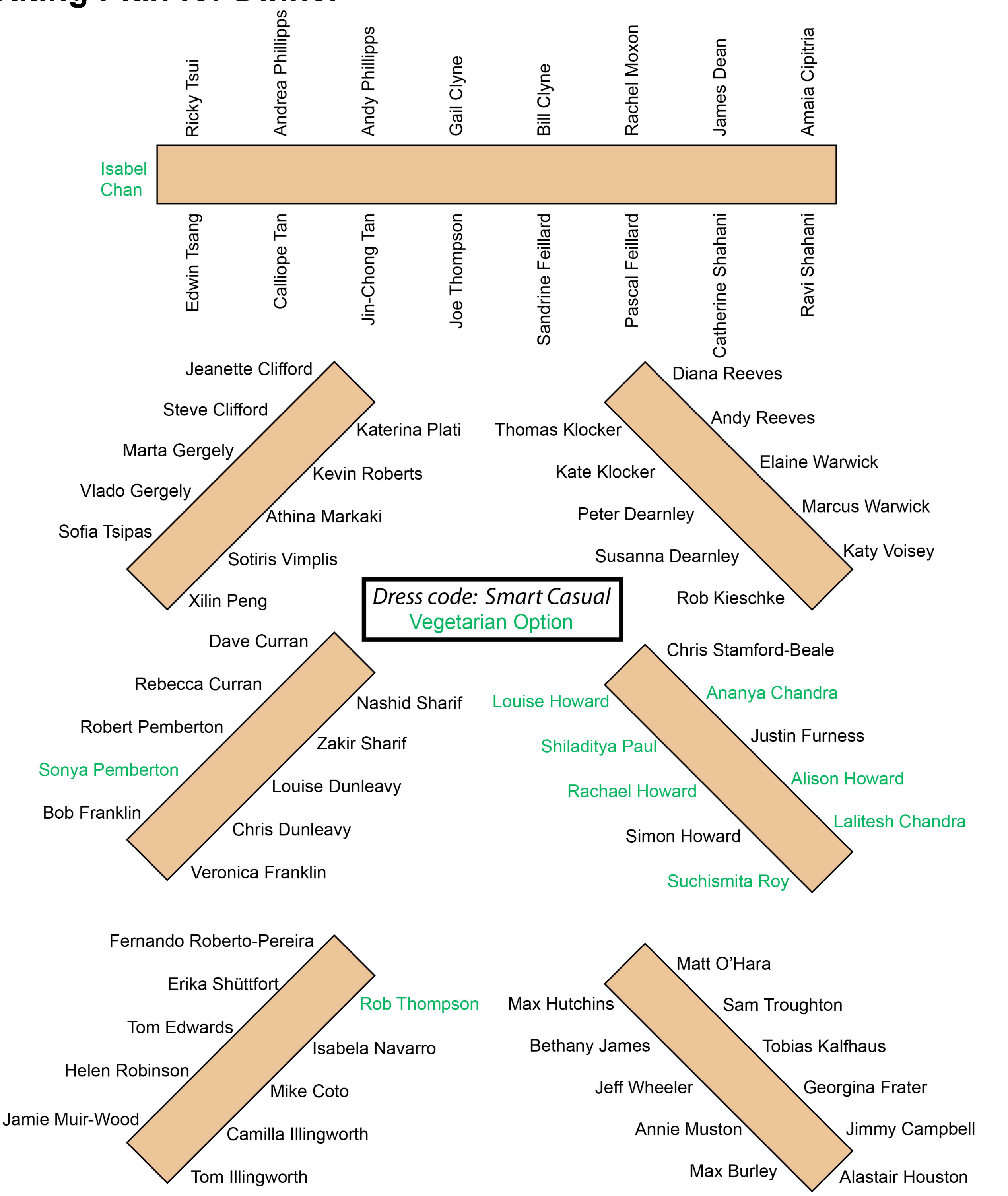
Friday 25th August

Time	No.	Presenter	Affiliation	Title
08.00-09.30				**Breakfast & Registration**
09.30-10.30				Session 1: **Surface Engineering & Testing Procedures** (Chair: **Bill Clyne**)
09.30-09.45	**1**	Jeff Wheeler	ETH Zurich	*Variable Temperature Nanomechanical Testing In Situ in the SEM*
09.45-10.00	**2**	James Dean	Cambridge University / DPC	*Material Properties from Instrumented Indentation Testing*
10.00-10.15	**3**	Sam Troughton	Cambridge University	*Recent Advances in Understanding of Plasma Electrolytic Oxidation*
10.15-10.30	**4**	Mike Coto	Cambridge University / Keronite	*Controlling the Surfaces in Photocatalytic Membranes for Water Purification*
10.30-10.45	**5**	Peter Dearnley	Boride Services Ltd	*The Pros and Cons of Surface Engineered 'Composite' Systems – Synergism or Antagonism?*
10.45-11.45				**Coffee**
11.45-12.30				Session 2: **Materials Science in Medicine** (Chair: **James Dean**)
11.45-12.00	**6**	Amaia Cipitria	Max Planck Inst. for Colloids & Interfaces, Potsdam	*Extracellular Matrix Biophysical Cues in Dormancy and Bone Metastasis*
12.00-12.15	**7**	Athina Markaki	Cambridge University	*3D Printing and Cellular Strategies to promote Vascularization in Tissue Engineering*
12.15-12.30	**8**	Helen Robinson	Burgoynes, London	*Forensic Materials Investigation*
12.30-14.00				**Lunch**
14.00-15.15				Session 3: **Materials and Composite Systems in Demanding Environments** (Chair: **Amaia Cipitria**)
14.00-14.15	**9**	Sonya Pemberton	Amec Foster Wheeler, Warrington	*Environmentally Assisted Cracking of Nuclear Materials*
14.15-14.30	**10**	Jin-Chong Tan	Oxford University	*From JETPOD (metal fibres) to MOFs (metal-organic frameworks) - In a Nutshell*
14.30-14.45	**11**	Xilin Peng	Seagate Technology LLC, California	*Thin film Photovoltaic (solar) modules: engineering for higher efficiency, better reliability and lower cost*
14.45-15.00	**12**	Alastair Houston	Cambridge University	*Novel Approaches to the Development of Diesel Particulate Filters*
15.00-15.15	**13**	Sofia Tsipas	Carlos III University, Madrid	*Ti_2AlC and Ti_3SiC_2 MAX phase foams*
15.15-15.45				**Tea**
15.45-17.00				Session 4: **Materials in the Wider World** (Chair: **Jin-Chong Tan**)
15.45-16.00	**14**	Joe Thompson	Virgin Atlantic, Crawley	*Commercial Aircraft Purchasing - Customer Perspectives*
16.00-16.15	**15**	Justin Furness	Council for Aluminium in Building, Gloucester	*Aluminium Stewardship Initiative and Responsible Sourcing*
16.15-16.30	**16**	Ricky Tsui	Arup, Hong Kong	*Deploying Viable Materials Solutions in Different Industries*
16.30-16.45	**17**	Andy Phillipps	-	*New Ventures*
16.45-17.00	**18**	Rob Kieschke	3M, Minneapolis	*Turning Innovation from Luck to Skill*
17.45-18.30				**Supper for children (Fleet Room)**
18.30-19.30				**Reception (Fellows' Garden, or SCR if wet)**
18.30-21.00				**Supervised activities for children (Fellows' Garden, or Fleet Room if wet)**
19.30-21.00				**Symposium Dinner (Hall)**

Delegates

Name <e-mail>	Affiliation	College	Guests	Symp. (25^{th})	Dinner (25^{th} 7.30pm)	Cafe Supper (25^{th} 5.45pm)	Punting (26^{th} 10am)	BBQ (26^{th} 6pm)	Nights in Downing	Parking in Downing
Attending Symposium										
Chris Stanford-Beale <chri	Analysis Mason	Darwin	-	1	1	x	x	x	x	x
Marcus Warwick <marcus.\	TWI	Johns	Elaine	1	2	x	2	2	x	x
Kevin Roberts <kar1002@	Cambridge U.	-	Wendy	1	1	x	x	2	x	x
Rob Kieschke <rrkieschke1	3M, Minneapolis	Jesus	-	1	1	x	1	x	24^{th}-27^{th}	x
Ravi Shahani <ravi.shahan	Constellium	Caius	Catherine	1	2	x	2	2	x	x
Justin Furness <justin.furn	Council for AI in Building	Downing	-	1	1	x	x	x	25^{th}	25^{th}-26^{th}
Andy Reeves <areeves@w	Wyman	Jesus	Diana	1	2	x	2	2	x	x
Peter Dearnley <peter_dea	Boride Services Ltd	-	Susanna	1	2	x	2	2	24^{th}-26^{th}	x
Andy Phillipps <andyphillip	-	Downing	Andrea	1	2	x	x	x	x	x
Lalitesh Chandra <Lalitesh	Unilever	Darwin	Suchismita Roy & Ananya (11)	1	3	x	3	3	x	25^{th}-26^{th}
Ricky Tsui <ricky.tsui@aru	Arup, Hong Kong	Hughes Hall	Isabel (veg), Edwin, Rosalyn (9) & Isaac (9)	1	3	2	5	5	x	x
Pascal Feillard <pascal.feil	PSA Peugot-Citroën	-	Sandrine	1	2	x	2	2	x	25^{th}
Xilin Peng <Xilin.Peng@se	Seagate Technology LLC	Downing	-	1	1	x	1	1	24^{th}-29^{th}	x
Vlado Gergely <vlado.gerg	GE Aviation	Johns	Marta	1	2	x	2	x	x	x
Joe Thompson <joe.a.thon	Virgin Atlantic	Downing	Liz & Phoebe (1)	1	1	x	3	3	x	x
Athina Markaki <am253@c	Cambridge U.	Rob.	Sotiris & Constantina (6)	1	2	1	x	x	x	x
Steve Clifford <stephen.clif	ABB	?	Jeanette	1	2	x	2	2	24^{th}-26^{th}	24^{th}-27^{th}
Katy Voisey <katy.voisey@	Nottingham U.	Downing	-	1	1	x	1	1	x	x
Thomas Klocker <thomas.k	America Merrill Lynch	Wolfson	Kate	1	2	x	x	x	x	x
Dave Curran <dccurran@g	UK Govt (BEIS)	Johns	Rebecca (some food intolerances)	1	2	x	2	2	25^{th}-26^{th}	x
Jin-Chong Tan <jin-chong.t	Oxford U.	Downing	Calliope	1	2	x	2	2	x	x
Tom Illingworth <tom.illingw	LEK	Catz	Camilla	1	2	x	2	1	x	x
Sofia Tsipas <stsipas@ing	Carlos III U., Madrid	Johns	-	1	1	x	1	1	25^{th}-26^{th}	x
Jamie Muir Wood <jmw@5	Hogarth Chambers	Peter.	-	1	1	x	x	x	x	x
Shiladitya Paul <shiladitya.	TWI	St. Edm.	-	1	1	x	1	1	x	x
Aikaterini Plati <katerina.pl	Cyprus Govt	Johns	-	1	1	x	1	1	25^{th}-26^{th}	x
Amaia Cipitria <amaia.cipit	Max Planck Inst. Colloids & Interfaces, Potsdam	Corpus	-	1	1	x	1	1	24^{th}-26^{th}	x
Jeff Wheeler <jeffrey.whee	ETH Zurich	Clare	-	1	1	x	1	1	24^{th}-26^{th}	x
Chris Dunleavy <cdunleavy	Venner-Shipley	Trinity	Louise, Morgan (3)	1	2	1	x	x	x	x
Helen Robinson <helen.rol	Burgoynes	Selwyn	Dan, Joel (3), Zac (1) & Samuel (1)	1	1	x	5	5	x	x
Sonya Pemberton <sonya.	Amec Foster Wheeler	Downing	Robert	1	2	x	2	2	24^{th}-26^{th}	24^{th}-27^{th}
Erika Shüttfort <oberg.erik	-	Downing	-	1	1	x	1	1	x	x
Veronica Franklin <veronsu	-	Trin. Hall	Bob	1	2	x	x	x	x	x
Max Hutchins <max.hutchi	Keronite International	Darwin	Bethany James	1	2	x	x	x	x	x
James Dean <jd362@cam	Cambridge U. / DPC	Darwin	Rachel & Findley (2)	1	2	1	3	3	x	x
Jimmy Campbell <jc682@c	Cambridge U.	Rob.	Georgina Frater	2	2	x	1	1	x	x
Nashid Sharif <ns583@cal	Cambridge U.	Fitz	Zakir & Zarif (6)	1	2	1	x	3	x	25^{th}
Sam Troughton <st514@ca	Cambridge U.	Rob.	-	1	1	x	1	1	x	x
Alastair Houston <ajh242@	Cambridge U.	Rob.	-	1	1	x	1	1	x	x
Fernando Roberto-Pereira	Cambridge U.	Downing	-	1	1	x	x	x	x	x
Max Burley <mb866@cam	Cambridge U.	Downing	Annie	1	2	x	2	2	x	x
Matt O'Hara <mo427@can	Cambridge U.	Downing	-	1	1	x	1	1	x	x
Mike Coto <michaeldan137	Cambridge U. / Keronite	Darwin	Isabela Navarro	1	2	x	2	2	x	x
Rob Thompson <rpt26@ca	Cambridge U.	Pembr.	-	1	1	x	x	x	x	x
Tom Edwards <teje2@cam	Cambridge U.	Jesus	-	1	1	x	1	1	x	x
Tobias Kalfhaus <t.kalfhaus	FZ Jülich	-	-	1	1	x	x	x	x	x
Bill Clyne <twc10@cam.ac	Cambridge U.	Downing	Gail	1	2	x	1	2	x	x
Not Attending Symposium										x
Steve Gill <stephen.gill@m	Mewburn Ellis	Caius	Ann	x	x	x	2	2	x	x
Simon Howard <simon.how	EDF Energy	Girton	Alison, Louise (14) & Rachael (12) (all veg)	x	4	x	4	x	x	x
Saiful Khan <drmsakhan@	Potter Clarkson LLP	Downing	Farheen, Aadil (17) & Bilaal (15)	x	x	x	4	x	x	x
Julien Paillard <julien.pailla	-	Corpus	Sarah Tarr	x	x	x	2	2	x	x
Tom Matthams <tjm16@ca	Cambridge U.	Clare	Lisa, Lara (10), Ben (7) & Kirsty (5)	x	x	x	5	5	x	x
			totals	48	78	6	77	71		
	punt captains			veg						

Seating Plan for Dinner

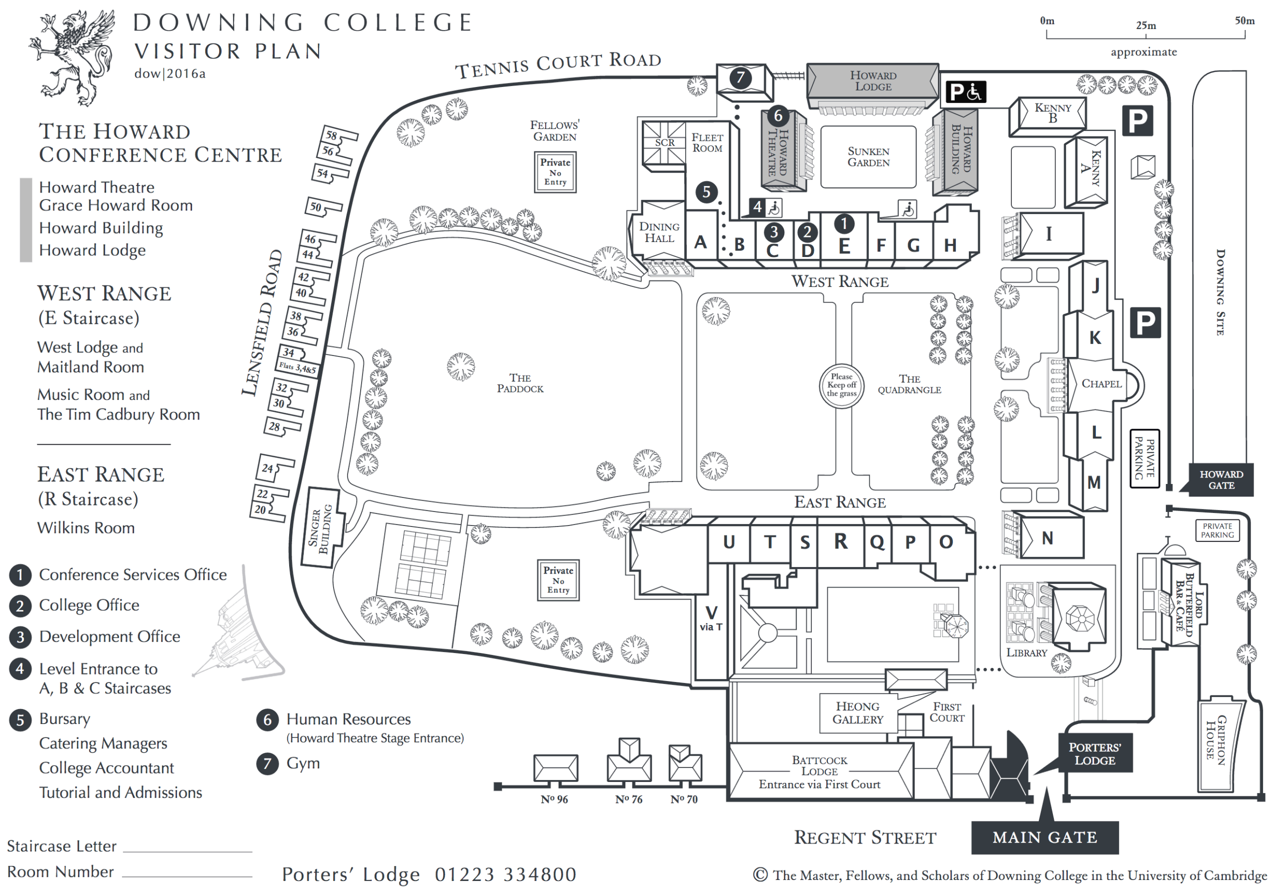


Café Supper & Supervised Activities:
Rosalin & Isaac Tsui (9), Constantina Vimplis (6),
Zarif Sharif (6), Morgan Dunleavy (3), Findley Dean (3)

Dinner Menu

Starter:	Ham hock pressing with grain mustard, apple piccalilli, compressed apple, celery cress, focaccia croute
Main:	Mini rack and pressed shoulder of lamb, pea and mint purée, crushed parsley potatoes and baby carrots
Dessert:	Passion fruit tartelet, with meringue and freeze-dried raspberries, raspberry compote, limoncello sorbet(v)
Veg. Starter:	Spiced chickpea cake, poached duck egg, pickled shallots, coriander cress
Veg. Main:	Ravioli of sweet onion and fennel seed, buttered spinach, white wine butter sauce, confit baby fennel

Plan of Downing College



Abstracts

Session 1 - Surface Engineering and Testing Procedures (Chaired by Bill Clyne)

Talk 1: Friday 25th August, 09.30-09.45

Variable Temperature Nano-mechanical Testing In Situ in the SEM

J Wheeler
ETH Zurich

For nano-mechanical testing in-operando conditions, temperature is a primary variable to be able to control to simulate operational conditions. Significant effort has been spent on achieving elevated temperature testing capabilities over the last two decades, and recently low temperature testing has also been achieved. By combining these two capabilities, a significant range of testing temperatures (-100 to 600°C), which spans a wide range of both homologous temperatures and operational conditions, is now accessible. Here, the considerations and procedures for achieving this type of testing in both the elevated temperature and cryogenic temperature ranges within a single testing system are discussed, and several case studies will be presented.

Talk 2: Friday 25th August, 09.45-10.00

Material Properties from Instrumented Indentation Testing

J Dean & TW Clyne
Cambridge University / DPC

The hardness and stiffness of materials are measured in a rather routine way from indentation tests. However, there has been (and there continues to be) a strong interest in the development of indentation methods for obtaining more complex (and potentially more useful) material behaviour parameters. Plasticity is one example, where the objective is to use indentation load-displacement curves to infer values for the yield stress and the parameters that describe the work-hardening behaviour (of metallic materials). Analytical methods have proven to be inadequate, since they cannot account for complex hardening behaviour and the evolution of complex stress and strain fields. Numerical methods (finite element modelling) have been much more successful, although no universally accepted methodology has yet emerged that is transparent, tractable and easy to implement and use. In this presentation, a simple methodology is presented for converging on best fit plasticity parameters from indentation data using inverse finite element methods. The robustness of the methodology is demonstrated using real experimental data and guidelines for ensuring the uniqueness of solutions are discussed. A stand-alone software tool called SEMPID, implementing the proposed algorithm, will be demonstrated. This package has been created using the COMSOL Multiphysics Application builder and its simplicity and ease of use are expected to offer broad appeal. Some industrial applications are presented as case histories towards the end of the talk.

Talk 3: Friday 25th August, 10.00-10.15

Recent Advances in Understanding of Plasma Electrolytic Oxidation

SC Troughton & TW Clyne
Cambridge University

Plasma electrolytic oxidation (PEO) is now a well-established industrial process for producing protective oxide coatings on metals such as Al, Mg and Ti. However, understanding of the fundamental processes involved during PEO is far from complete. Determining the characteristics of individual discharges is central to addressing these issues. Techniques developed in The Gordon Lab have enabled detailed study of individual discharges using a unique set-up, combining electrical monitoring synchronised with high speed optical imaging. This has been used to gain insight into mechanisms of discharge initiation, their effects on coating microstructure and energy absorption during a discharge. A review of these characteristics will be presented, with comparisons between the responses of various metals suitable for PEO processing.

Talk 4: Friday 25th August, 10.15-10.30

Controlling the Surfaces in Photo-catalytic Membranes for Water Purification

M Coto
Cambridge University / Keronite

Photo-catalysis is a light-activated redox reaction that can produce highly oxidising species when in contact with water. These reactions have long been utilised in the field of water purification to oxidise both organic chemicals and biological contaminants. Traditionally, photo-catalytic materials have been used in the form of nano-powders, due to their exceptionally high surface area and resultant reaction rates. However, for the application of photo-catalytic water treatment, nanoparticle use is suspension is unattractive, due to the cost and complexity of removing these suspensions in a post-treatment step. The use of porous photo-catalytic membranes offer an attractive solution to the nanoparticle problem, owing to their potentially high surface area, ability to retrofit into existing purification systems and flow-through arrangements favouring catalyst-pollution interactions. In this presentation, the development of several different TiO_2-based photo-catalytic membranes is discussed. These are synthesised using a variety of substrates, including glass fibres, cellular foams and metal weaves, and are coated with photo-catalytic materials using sol-gel chemistry, binders and the plasma electrolytic oxidation technique. The relative advantages and disadvantages of each membranes type will be discussed, as well as the challenges in making meaningful comparisons in photo-catalytic efficiency.

Talk 5: Friday 25th August, 10.30-10.45

The Pros and Cons of Surface Engineered 'Composite' Systems – Synergism or Antagonism?

PA Dearnley
Boride Services Ltd

To paraphrase the late, and possibly 'great', Professor Thomas Bell of the University of Birmingham, surface engineered materials are true composite systems in that they represent a finely tuned synthesis of established substrates, based on metals, ceramics or polymers with a surface engineered layer (SEL) that displays outstanding surface qualities. This harmonious combination of materials are ubiquitous in many engineering objects, that we all take for granted, ranging from high-tech gas turbine and auto engine components, to advanced cutting tools, bio-medical devices and more mundane everyday objects like the humble bathroom mirror. Over many years, the author has personally strived to form a deeper understanding of the benefits and limitations of surface engineered objects. Whilst such composite systems often mitigate against surface degradation problems that afflict unprotected materials, an example of synergistic benefit, in a few cases, surface engineered objects suffer their own degradation pathways that might prove worse than no-surface engineered materials, exemplifying a negative antagonistic outcome. Specific examples will be illustrated in the talk.

Session 2 - Materials Science in Medicine (Chaired by James Dean)

Talk 6: Friday 25th August, 11.45-12.00

Extracellular Matrix Biophysical Cues in Dormancy and Bone Metastasis

A Cipitria

Max Planck Inst. for Colloids & Interfaces, Potsdam

Synthetic cell instructive materials allow independent control of biophysical properties and have contributed to the understanding, how cells sense extracellular matrix (ECM) biophysical cues in tissue regeneration. Materials science approaches have also been used to investigate different steps in cancer progression, such as tumour growth, homing or metastasis. Breast cancer is one of the leading causes of cancer-associated deaths among women worldwide. Breast cancer often metastasizes to bone, which can occur even after 10 years following tumour resection. This implies that cancer cells can undergo a dormancy phase. Three mechanisms have been identified: (i) dormancy of solitary cells, (ii) angiogenic tumour dormancy (cell division balanced by apoptosis) and (iii) immunosurveillance. In dormancy of solitary cells the interaction with the microenvironment is pivotal. However, the role of ECM biophysical cues in dormancy and reactivation is poorly understood, in part due to a lack of good in-vitro and in-vivo models. We hypothesize that the local biophysical microenvironment modulates breast cancer cell dormancy in the bone marrow and altered matrix biophysical cues can trigger cancer cell proliferation. The goal of this project is to contribute to the understanding, how biophysical mechanisms regulate cell-matrix interaction in dormancy and bone metastasis, by (i) synthesizing biomimetic cell microenvironments and (ii) developing characterization and imaging methods to study the early metastatic and dormant niche in-vivo. An improved understanding could lead to novel therapeutic approaches, such as to provide cues to ensure a dormant state, or to annihilate the niche and, with it, the cancer cell reservoir.

Talk 7: Friday 25th August, 12.00-12.15

3D Printing and Cellular Strategies to promote Vascularization in Tissue Engineering

AE Markaki

Department of Engineering, Cambridge University

The networks of blood vessels that comprise the circulatory system provide living tissue with the required nutrients and oxygen, whilst removing waste products. The lack of such a functional transportation system, known as “vascularization”, within a large and densely populated tissue engineered construct leads to necrotic core formation, preventing fabrication of functional tissues and organs. Strategies for vascularization involve engineering vascularized tissue before transplantation into the patient or by promoting vascularization in situ after transplantation. This talk will focus on our recent work in these areas. More specifically, the presentation will cover: (i) a multi-casting approach for production of three-dimensional, hierarchical and perfusable vascular networks using sacrificial 3D printing (Justin et al, Journal of Royal Society Interface 2016) and (ii) the design of an artificial bile duct, made of densified collagen, for reconstruction of the middle portion of the native common bile duct in a mouse model (Sampaziotis et al, Nature Medicine 2017).

Talk 8: Friday 25th August, 12.15-12.30

Forensic Materials Investigation

HJ Robinson
Burgoynes, London

Why did the glazing shatter, pinholes form in my pipework, plumbing joints separate, a tank collapse, carbon fibre forks on a bicycle shatter,...? These are just some examples of incidents that can be explained by a good basic understanding of areas of materials science and metallurgy, or in some cases with the assistance of detailed materials analysis techniques. This talk aims to give an overview of different incidents that forensic materials scientists are instructed to investigate and the failure analysis techniques used to understand why they occurred.

Session 3 - Materials and Composite Systems in Demanding Environments
(Chaired by Amaia Cipitria)

Talk 9: Friday 25th August, 14.00-14.15

Environmentally Assisted Cracking of Nuclear Materials

SR Pemberton, S Medway & J Stairmand
Clean Energy, Amec Foster Wheeler, Beechwood, Warrington, UK

Years of materials development within the nuclear industry have led to the production and use of high performance alloys. However, Environmentally Assisted Cracking (EAC) remains of concern when predicting plant lifetimes, particularly in environments where inspection and maintenance can be challenging, costly and of radiological significance. The requirement that components withstand high temperatures and pressures in a primary water environment for periods of over 60 years has driven a need to understand the EAC of nuclear materials. Amec Foster Wheeler's corrosion laboratories in Birchwood have been the leading nuclear testing laboratory in the UK for several generations. Testing programmes undertaken are allowing a mechanistic understanding of EAC, including Stress Corrosion Cracking (SCC), and Environmentally Assisted Fatigue (EAF), to be generated. Factors affecting EAC resistance include the material's chemical composition; prior heat treatments; the presence and orientation of residual strains in welds or mechanical work in forged materials; surface condition as a result of machining; chemical environment, with hydrogen and oxygen contents of particular relevance in primary water environments; and electro-chemical potential in addition to applied stress and temperature. A variety of innovative techniques have been used to accelerate environmental testing, including elevated temperatures up to 360°C and high stresses, in order to simulate nuclear plant conditions, by the application of tightly controlled water chemistries and the use of complex fatigue waveforms, negative R ratios, and thermo-mechanical fatigue testing. Crack growth can be monitored in real time down to rates of 1×10^{-13} m s^{-1}, with crack initiation detectable in an EAC test at depths of 200 μm using on-line electronic monitoring techniques. Metallographic analysis, by 3D microscopy, SEM, EDS, EBSD, micro-hardness testing and XRD is used to interpret fracture surfaces generated, and to study the effect of factors such as residual stress, surface condition and texture. Knowledge of the tensile properties of a material is also essential to understand factors affecting EAC and to tailor initiation testing to ensure cracking within timescales achievable in a laboratory. Following on from successful EAC testing programmes, the laboratory has been chosen to host the government's open access High Temperature Facility. This facility enables fracture, creep and fatigue testing in conditions of relevance for next generation nuclear reactors, such as elevated pressures, liquid metal environments and temperatures up to 1000˚C.

Talk 10: Friday 25th August, 14.15-14.30

From JETPOD (Metal Fibres) to MOFs (Metal-Organic Frameworks) - In a Nutshell

JC Tan
Oxford University

The first part of the talk will touch upon interesting developments in the field of porous materials — as I had experienced it — first as a PhD student and later as a postdoc in the Gordon Laboratory, where we have studied the network architecture and thermomechanics of stainless steel fibres [1]. Such bonded fibre networks are potentially useful for acoustic attenuation in an extreme environment [2]. The second part of the talk will highlight several recent achievements in my group at Oxford (2012-), where the focus is on hybrid nanoporous materials, termed metal-organic frameworks (MOFs) [3]. Recent developments include innovative processing routes to engineer MOF-polymer composites and thin-film coatings *via* electrospinning, membrane casting, 3D printing and sol-gel techniques [4]. The mechanical anisotropy, photophysical properties and durability of bespoke MOF-based materials have been studied aimed at a number of technological applications [5].

[1] Tan JC, Elliott JA, Clyne TW. *Analysis of Tomography Images of Bonded Fibre Networks to Measure Distributions of Fibre Segment Length and Fibre Orientation*, Adv. Eng. Mater. 2006;**8**:495.

[2] (a) Golosnoy IO, Tan JC, Clyne TW. *Ferrous Fibre Network Materials for Jet Noise Reduction in Aeroengines - Part I: Acoustic Effects*, Adv. Eng. Mater. 2008;**10**:192; (b) Tan JC, Clyne TW. *Ferrous Fibre Network Materials for Jet Noise Reduction in Aeroengines Part II: Thermo-Mechanical Stability*, Adv. Eng. Mater. 2008;**10**:201.

[3] Tan JC, Civalleri B. *Metal–Organic Frameworks and Hybrid Materials: From Fundamentals to Applications*, Cryst. Eng. Comm. 2015;**17**:197.

[4] (a) Titov K, Tan JC. *Facile patterning of electrospun polymer fibers enabled by electrostatic lensing interactions*, APL Mater. 2016;**4**:086107; (b) Mahdi EM, Tan JC. *Mixed-matrix membranes of zeolitic imidazolate framework (ZIF-8)/Matrimid nanocomposite: Thermo-mechanical stability and viscoelasticity underpinning membrane separation performance*, J. Membr. Sci. 2016;**498**:276.

[5] Chaudhari AK, Kim HJ, Han I, Tan JC. *Optochemically Responsive 2D Nanosheets of a 3D Metal–Organic Framework Materia*l, Adv. Mater. 2017;In Press.

Talk 11: Friday 25th August, 14.30-14.45

Thin Film Photovoltaic (Solar) Modules: Engineering for Higher Efficiency, Better Reliability and Lower Cost

XL Peng
Seagate Technology LLC

A brief introduction on the Photovoltaic modules is first presented to answer these questions: 1) why we are interested in it, 2) How to make it, 3) Various categories of photovoltaic technologies and 4) What determines its energy conversion efficiency? Engineering considerations from selection of glass substrate, CdTe-CdS P-N semiconductor coatings, to process conditions (temperature, stress, microstructure control, laser scribing etc.), front/back contacts are discussed to address the requirements for: a) minimized Na diffusion from glass substrate and its edge and surface stress loss, b) maximized light transmission and absorption within the CdTe layer, c) maximized photo generated carrier (electron-hole) collection, and d) improved long term environmental reliability. With the optimization of the above key aspects, high efficiency and low cost photovoltaic modules can be fabricated in industrial scale at competitive cost.

Talk 12: Friday 25th August, 14.45-15.00

Novel Approaches to the Development of Diesel Particulate Filters

AJ Houston & TW Clyne
Cambridge University

Ongoing concerns about adverse health effects of carbon particulate in Diesel engine exhausts continue to drive the quest for improved performance from Diesel Particulate Filter (DPF) systems. Two of the main areas in which improvements are being sought are enhanced filtration efficiency of very fine particles (<~50 nm), particularly immediately after regeneration (the periodic removal of accumulated particulate via combustion), and improved thermal shock resistance. One approach to achieving these aims is to create novel composite materials via the introduction of ceramic fibres. This has the potential both to enhance the fracture toughness, by promoting fibre pull-out, and to improve the filtration efficiency by creating multi-scale structures, with some gas flowing through very fine channels, while the presence of other coarser pathways ensures that the overall permeability remains acceptably high. This presentation covers the creation of novel DPF structures containing fine ceramic fibres and measurement of their porosity and permeability. It is concluded that there is scope for significant improvement in overall DPF performance via the incorporation of fine fibres.

Talk 13: Friday 25th August, 15.00-15.15

Ti_2AlC and Ti_3SiC_2 MAX phase foams

SA Tsipas
Carlos III University, Madrid

MAX phases are ternary carbides and nitrides with a hexagonal structure and the general formula Mn+1AXn where M is an early transition metal, A is an A-group element and X is either nitrogen or carbon. Due to their structure they have and unusual combination of properties exhibiting both metallic characteristics such as high electrical and thermal conductivity, machinability, damage tolerance and ceramics characteristics such as thermal shock resistance high elastic stiffness and low thermal expansion coefficient. MAX phase foams have a great potential for various applications where tailored functional and mechanical properties are required. Most of the research on Ti_2AlC and Ti_3SiC_2 MAX phases is focused on dense material and there are few studies on porous MAX phases. Porous MAX phases can find applications in: substrates for catalysts devices, porous electrodes, chemical filters, electrolyte clapboards, hot gas filtration, diesel particulates filters and others. Porous MAX phases offer a better combination of properties than the conventional porous ceramics since they achieve good mechanical properties at high temperature in addition to being electrically and thermally conductive and also having excellent machinability.

Session 4 - Materials in the Wider World (Chaired by Jin-Chong Tan)

Talk 14: Friday 25th August, 15.45-16.00

Commercial Aircraft Purchasing - Customer Perspectives

JA Thompson
Virgin Atlantic

A good case can be made that fleet choices are among the most impactful decisions a commercial airline makes. They certainly have long term implications, with delivery lead times and in-service life combining to mean a carrier will benefit from the right choice (or suffer from the wrong one) for over twenty years. This talk will provide an overview of how aircraft purchasing campaigns are run, the factors considered and some high-level insights into the role materials science plays in influencing the outcome.

Talk 15: Friday 25th August, 16.00-16.15

Aluminium Stewardship Initiative and Responsible Sourcing

J Furness
Council for Aluminium in Building, Gloucester

So you now know that your lasagne does not contain horse, but where did the aluminium foil packaging come from? When a commodity such as aluminium is traded across the globe, how do you know whether it was responsibly sourced? The Aluminium Stewardship Initiative (ASI) was launched in 2012-13 with the aim to establish an independent, third-party certification programme. This presentation will explain how ASI will establish a chain of custody for aluminium, with particular emphasis on the construction sector.

Talk 16: Friday 25th August, 16.15-16.30

Deploying Viable Materials Solutions in Different Industries

YC Tsui
Arup, Hong Kong

There are many reasons, such as change in market trend, regulation, policy, price and functional requirement that will trigger the search for new materials or alternative processing methods for many products or components in different industries. The main task of a materials engineer is to fulfil the ever-changing needs and deliver appropriate solutions. That spans from understanding the needs, identifying possible materials and/or their processes, conducting research and feasibility studies to solving the mass production issues. Examples will be given on those needs from various traditional manufacturing industries, such as jewellery, watch, spectacles, metal forming involving the processes like metal alloying, Physical Vapour Deposition, metal and ceramic injection moulding, and semi-solid casting. Recent application cases in building and construction industry will be briefly mentioned including corrosion protective coatings, algae as a biomaterial, organic solar cells, etc.

Talk 17: Friday 25th August, 16.30-16.45

New Ventures

AC Phillips

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Start-ups, or New Ventures, are estimated to have generated up to 80% of the employment in the UK over the last decade and are believed to be one of the necessary lubricants for a smoothly operating capitalist society; enabling both the fairer redistribution of wealth and the maintenance of national competitive advantage. As a consequence of this, the UK government subsidises start-ups to the tune of billions of pounds per annum. With over 60% of all start-ups failing, and the associated losses for tax-payer, investors and entrepreneur, understanding the drivers of success for start-ups is obviously important. Andy will review some of these critical success factors for start-ups and illustrate these with anecdotes from his personal experience showing the consequences of getting them wrong. He will also discuss the advantages and disadvantages of scientific rigour in a start-up.

Talk 18: Friday 25th August, 16.45-17.00

Turning Innovation from Luck to Skill

RR Kieschke

3M, Minneapolis

After 26 years working at one of the world's most innovative materials companies in various new product development roles, I will go through some of the essential features of creating a new, materials based business. Typically, new start-ups have success rates of less than 5% yet we have been able to deliver success rates of over 50% with the right approach. We consider the quality of the initial idea and contrary to most of the advice during brainstorming sessions, there are indeed bad ideas. Next, we consider the process where rather than a linear stage gate-like process, we develop a road map that creates the best path to development. The attributes of the development team are also critical where the roles of the architect, the innovator and the specialist are defined. Beyond that, without the right culture, the chance of success will be greatly diminished. The correct expectations, goals and reward system are critical to, not only drive the team, but to create the environment where it remains engaged and focusses on the correct goals.