

## Preface

### Plasma-based Surface Engineering

Celebrating the research career of Professor Allan Matthews, FREng



This Special Issue celebrates and honours the pioneering and illustrious research track-record, and unprecedented journal editorial career, of Professor Allan Matthews FREng – who, in 2022, has now spent a remarkable 35 years as an Editor of *Surface & Coatings Technology*, alongside an even more remarkable >45-year research career (from the 1970's forward – and still counting...!) in almost all aspects of Surface Engineering, but particularly in areas such as advanced surface coatings development/evaluation, and tribology/corrosion test methods. The 40 scientific papers contained within this Special Issue of *Surface & Coatings Technology* emanate from colleagues and their research groups around the world – for whom Allan's vision, research and educational leadership, friendship and support have been instrumental/inspirational in the development of their own research careers – including also the Guest Editors of this Special Issue!

Allan is one of the 'select few' in our field who was at the forefront of the discipline of what is now called 'Surface Engineering' – before it became known as such to the wider engineering coatings and materials

science scientific/industrial communities. He was a pioneer of many of the plasma-assisted PVD coating technologies and tribological coatings test and evaluation techniques that we are all familiar with today. Following his upbringing around Wigan, in the northwest of England during the 1950's–1960's, Allan's academic career started in the same region, at Salford University in the 1970's – firstly as a BSc Honours graduate in Mechanical Engineering in 1974 followed, after several years working in the UK Aerospace Industry, by a return to postgraduate academic studies at Salford University – graduating in 1980 with a PhD qualification on the topic: 'Thermionically-Assisted Triode Reactive Ion-Plating System for TiN Coating'. Without question, Allan's PhD work at Salford on plasma-assisted electron-beam PVD was one of the key innovation steps towards the intensification of academic research on (and widespread industrial commercialisation of) PVD ceramic coatings during the 1980's. This triggered, by his own definition (of the '*Four Waves of Surface Engineering*'), the *second wave* in PVD technology which transformed the rather inefficient and niche original PVD processes (such as DC diode ion plating and 'Ivadisising' developed during the *first wave*, in the 1960's–1970's), focusing initially on industrial metal cutting tools but soon followed by innumerable other applications – and indeed such transformations led to the concurrent emergence at that time, of Surface Engineering as a recognised scientific discipline in its own right.

Soon after his PhD graduation from Salford University, Allan joined in 1982 the new department of Engineering Design and Manufacture at the University of Hull as a young lecturer and, within three years, had established his own Surface Engineering research group – one of the first of such, worldwide – that, by the late 1980's, had rapidly grown and developed to become the widely-renowned Research Centre in Surface Engineering. The 'RCSE' continued to grow and flourish during the 1990's, with four of the five Guest Editors of this journal volume either graduating as a PhD student under Allan's supervision, or joining the team as a Postdoctoral Researcher, in the 10-year period between 1991 and 2000. That time was marked by the emergence of what Allan would describe as the *third wave* in PVD technology, associated with the development of competitive sputter/sputter-arc deposition systems, including unbalanced magnetron, closed-field and arc-bond sputter processes, that were enabled by the new solid state and pulsed power supply technology and sophisticated process control systems now becoming available. Several of these new, 'intensified-plasma' processes were intensively researched in the RCSE, and were also expanded into non-vacuum plasma surface engineering techniques, inspiring the emergence of new research fields such as electrolytic plasma processing and, specifically, Plasma Electrolytic Oxidation (PEO). In this period, the RCSE was a very special place for several generations of graduate students. Allan's office door was always open, and he was always ready to discuss results (or the lack thereof!) – no matter how difficult his

group of international scholars must have been for him to understand, initially. Allan infused a 'Can Do' mentality in his junior researchers; but there were also a number of very knowledgeable, diligent and patient senior researchers – themselves also equipped with the same mentality and team spirit – who had been educated/enthused/inspired by Allan. In particular, Adrian Leyland, Kevin Fancey and Adrian James all provided the day-to-day help needed to get things (eventually) done. In the mid-1990's, Andrey Voevodin also quickly became an invaluable member of this RCSE 'mentor group'. Within such a supportive environment, research students could grow and flourish – and Allan has always believed in working hard and leading by example; we remember the famous quote attributed to Thomas Edison: 'Genius is one percent inspiration and ninety-nine percent perspiration', that Allan posted prominently on his office wall. This statement left very little margin for misunderstanding of the approach to Surface Engineering research expected of his team and, as a result, the RCSE was a great place to work and grow.

From 2003 onwards, Allan moved his Research Centre to the University of Sheffield, where the group continued to grow and develop in the department of Materials Science & Engineering for a further decade, until Allan returned to his 'home turf' of the north-west of England, joining the University of Manchester in 2016 – where he still works to this day. Allan's influence on the most recent technological transformations – that could be defined as the rise of the *fourth wave*, of 'Intelligent' Surface Engineering – based on equipment and process digitalisation, adaptation to the concepts of Industry 4.0 & Industrial-IoT, and holistic approaches (including sustainability and life cycle analysis of surface engineered products), continues to be immense. Meanwhile, Allan's academic leadership over the years has been exemplified in roles such as the Head of Department in Engineering Materials at the University of Sheffield, and as the Director of the BP International Centre for Advanced Materials (ICAM) at Manchester. It would not be an exaggeration to say that his current true enthusiasm and passion rest primarily with the UK EPSRC Network+ in 'Digitalised Surface Manufacturing', which inspires researchers and industrialists from across the globe with a vision for the future of Surface Engineering and Coatings Technology.

Aside from plasma-assisted PVD, Allan is also known for his major contributions to many other key areas in Surface Engineering; for example, he was among the first to develop and evaluate scratch adhesion test methods for hard coatings and he also has a long-standing track record in developing coating mechanical wear tests – including pin-on-disk, reciprocating-sliding, ball-on-plate impact and micro-abrasion testing. His understandings of surface contact mechanisms and wear process phenomena in tribology have led him to develop advanced coating design methodologies (e.g. the concept of using the H/E ratio in evaluating tribomechanical properties; duplex/hybrid treatments & coatings; nano-composite & glassy-metal films) and to construct computer-software based algorithms for coating and treatment selection – areas of research in which he has been a pioneering influence from the 1980's until the present day. Allan also pioneered the use of novel corrosion test methods for ceramic and multi-layered coatings – particularly Electrochemical Impedance Spectroscopy, which is now employed quite widely for coating evaluation but was little-known by the Surface Engineering community before the mid-1990's. Furthermore, over the last 20 years Allan and his research team have been instrumental in promoting the benefits of electrolytic plasma processing, particularly PEO – a technological breakthrough that has revolutionised the Surface Engineering of light-weight metals & alloys. Co-authored with two of the Guest Editors of this Special Issue, his seminal 1999 review paper on the subject (published in Surface & Coatings Technology) has been cited nearly 3000 times. In fact, Allan has published >400 refereed Journal papers in the last 40+ years which have, collectively, been cited (on Scopus) over 22,000 times – yielding an impressive h-Index of 70. Allan has also co-authored numerous influential textbooks in the Surface Engineering field – the most prominent of which is arguably the Elsevier publication 'Coatings Tribology' (in collaboration with Prof Kenneth Holmberg), that is for many the 'go to' textbook on

this subject, and is persistently highly-cited by others in the field. Other research topics where Allan has fostered key developments – or has been an 'early adopter' of new ideas/concepts – include: low-pressure plasma-diffusion treatments (for hybrid integration with PVD coatings), low-temperature diffusion hardening treatments for austenitic alloys (i.e. 'expanded austenite'), plasma-assistance for electron-beam PVD of thermal barrier coatings, and discharge modelling/diagnostic techniques in both vacuum-plasma and plasma-electrolytic processing. He has also, over many years, co-authored a number of influential papers on diamond-like carbon (DLC) coating processes – including several highly-cited reviews of DLC properties and applications.

Allan has always been a great ambassador of Surface Engineering both within and outside of the academic research community – through his roles in conference organisation/chairmanship (ICMCTF, PSE, SVC and others), membership/leadership of learned societies and professional bodies (AVS, FIMMM; FIMEchE, FIEE, FIMF, RAEng). Since the early 1990's, his highly regarded 'UK Engineering Coatings Market' surveys, as well as contributions to (and/or interactions with) UK and International Surface Engineering initiatives and organisations, such as SEAC-SIG (UK), (SELF, UK), SEAM (Australia), greenSEAM (Canada), AC2T (Austria), have broadly supported and influenced UK National – and worldwide International – public policies to support the development of future generations of Surface Engineering researchers/practitioners.

Last but not least, we should mention in more detail Allan's 35-year role as an Editor of Surface & Coatings Technology. The Guest Editors believe that they can, from their own personal experiences, speak for many others involved (one way or another) in the Editorial procedures and processes for this journal over the years, in expressing their gratitude to Allan for his supportive and constructive attitude to all aspects of his Editorial role. In parallel with the 'open door' policy described above (in regard to Allan's mentorship of his research group), we have seen firsthand how Allan treats everyone involved (both the submitting authors/reviewers and the administration/publication teams) in SCT as 'one big family'. Allan's honesty, integrity and 'collegiate' approach to every aspect of journal management has been appreciated by countless researchers over the years and, led by his example, has no doubt inspired many of us to at least try to replicate his impeccably high standards in our own research careers. The family feeling that Allan's editorial custodianship engenders has surely encouraged many of us to also become more closely involved with the SCT 'family' – and to publish (and continue to publish) our work in this journal – with our collective efforts (and Allan's inspirational leadership and support) contributing significantly to the healthy and growing impact of Surface & Coatings Technology in the science and engineering research publication community.

*We are all very grateful to you, Allan! Thank you!!*

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