



EPSRC NetworkPlus In Digitalised Surface Manufacturing Allan Matthews University of Manchester and The Henry Royce Institute











What do we mean by

Digitalised Surface Manufacturing?

Put simply, this means being able to represent in digital form all coatings and the processes by which they are produced.

Digitalisation has been found to be particularly vital for the Surface Manufacturing sector.

Report from KTN on SEAC

TIME FOR STRATEGIC CHANGE: UK SURFACE ENGINEERING AND ADVANCED COATINGS INDUSTRY

A REPORT BY THE SEAC SPECIAL INTEREST GROUP



Special Interest Group Surface Engineering and Advanced Coatings

In June 2014 a Special Interest Group established by the KTN to examine the Surface Engineering and Advanced Coatings (SEAC) sector produced a Report which has achieved buy-in from across the sector (Industry and Academia) and this is leading to major changes.

The report can be downloaded by following the link below.

https://connect.innovateuk.org/web/material sktn/article-view/-/blogs/surface-engineeringand-advanced-coatingsreport?p_p_auth=M1BcARlz 4

Also Important: UK Government Policy

Forging our future: Industrial Strategy - the story so far. A Government policy paper (published December 2018)

The aim is to build on the strengths in the UK and lead the industries of the future via <u>4 pillars (grand challenges) and 5 drivers of productivity.</u>

The Made Smarter report estimated **benefits of** adopting **Industrial Digital Technologies** to be upto **£455bn in next decade** for UK manufacturing sector.

The UK coating manufacturing industry is worth £11bn and the related products/applications £140bn.

Currently, **no UK university has** all the required **interdisciplinary expertise** and there is lack of connected knowledge in the area of digitalisation in surface engineering.







UK Government's Made Smarter Review, 2017:

"The UK is behind other advanced nations in overall productivity (output per worker), which is in part due to lower levels of adoption of digital and automation technology. This is particularly acute among SMEs"



Positioning of DSM





Innovation ecosystem







Benefits of Digitalisation





The overall benefits for closing the "Digital Gap" can be summarised as follows:

- Better utilisation of assets
- Reduce dependency on tacit knowledge
- Reduce the time and cost linked to product verification
- Improves and gives visibility to all business performance metrics Yield, Right First Time,
 Cost, Delivery, Quality and Equipment Effectiveness
- Enables and improves Design for Manufacture
- Opens up new business opportunities
- Provides a framework for developing a resilient business

To achieve IoT Integration, coating processes must be fully digitally monitored using cyber physical devices. Example: HVOF Thermal Spray Coatings (Courtesy Bryan Allcock)





Flame

11

- Worn parts can be identified through Spectral Density (thermal and visual).
- Correlation of coating properties with Acoustic **Emission signals**
- Noise peaks can be identified ۲ from process issues.





Plasma assisted electrolysis

Advantages

- Faster deposition
- No pre-treatment
- Better protection
- Non toxic reagents
- Compatible with complex shapes
- Wide range of surface properties





Basic equipment

- Power supply
- Cell
- Specimens
- Sensors/digitizer
- Data logger
- Cooling, extracting gas etc.



MANCHESTER Intelligent plasma assisted electrochemistry



The University of Manchester







• Starting conditions

MANCHESTER

The University of Manchester

1824

- In-situ quality criteria
- Final characteristics





Digital twin



- Software based model of the manufacturing process
- System behaviour through all steps of fabrication
- Optimization in digital form
- Reference manufacturing pathway



Source: 1991 J.Cameron "Terminator 2"

• Quality criteria

DSMN+ has built a strong presence



STAY CONNECTED AND FOLLOW US

Help the network grow!

Network website: www.digitalisedsurfacemanufacturing.com

<u>Register</u>: Please register with us on DSM website

Twitter: @dsm_network

LinkedIn: DSM Network or

contact@digitalisedsurfacemanufacturing.com

YouTube channel: DSM Network

Newsletter: News and updates on DSM activities

Top Tweet samed DSM Featured Wet 2020, 12 noon - 1 s		erekc London South Bank I	L	NKED		s united Kingdom 2 e North Carolina awa 2	Engineering and Physical Sciences Research Council	27 November 2020, 12 noon
Please join the session by criticity on the link below. Join Zoom Meeting	Big thanks to the Precision Engineering Journal for allowing us to present detailed insights into digitalisation:	University of North Cerolica at 1		Guilty Asserve Teller	2	Jin Keal Inco 2	EPSRC NetworkPlus	FEATURED WEBINAR
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				Geologia	ł.	Edioburgh: United Kingdom 1		State engineer. Hore in the oppications are onloss business development. Working in sales, foe is now sible for Polytec's international customers.

DSM Featured Webinar: Every Month



EPSRC NetworkPan in Digitalised Surface Manufacturing. The DRN NetworkPan is a filmilion investment by the IPSRC to bring sogether the diverse expense of diverse expense of D one of March 20(1)



NEWSLETTER

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Emerson and Renwick Ltd

last week we ha

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Prof Allan Matthews of Manchester University and Dr Saurav Goel of London South Bank University visited E&R with two of their postdoctoral researchers. Allan is the Director and Saurav is Associate Director of the EPSRC-sponsored "Digitalised Surface Manufacturing" Network, which aims to bring together academic researchers from across the UK to address the research challenges of introducing digitalisation and "Industry 4.0" concepts into the surface manufacturing industry. They see R2R technology as the key enabling technology for the future, which will address a wide range of application sectors and societal challenges. Allan and Saurav said that they were incredibly impressed with E&R's technology level and the company's facilities. They particularly appreciated the engineering vision of the company and its dedication to innovation, particularly in relation to in-process monitoring and control.

Nick Butcher Process and Equipment Development director comments " We are delighted to welcome the EPSRC team to our facilities, to help bridge the gap between academic and industrial needs, in implementation of next generation coating and web handling equipment for multiple different thin film applications."

#innovation #vacuum #research #development



DSMN+ Social Media Statistics (Indicator)



DSM Network **You-tube-** The figure means that that many times people watched our content on the you-tube and total watch hour

Twitter- The figure means that that many times people engaged with our content including, profile visits. registration, comments, likes, retweets- People are aware of our presence

LinkedIn- The figure means that that many times people engaged with our content including, likes, profile visits, registration, comments, etc



Webinars, Training courses and Other Engagements



Events, Training courses and Other Engagements





11 Oct 2021

Tackling COP26 challenges using digitalised surface manufacturing

62 people registered 55 people attended 173 times the recording was watched on YouTube

- 50% of speakers were female
- 36% of speakers were ECRs
- 45% of speakers were BAME
- 100% of female ECR speakers were BAME



CovUP-19 LEARN MORE CovUP-19 LEARN MORE CovUP-19 LEARN MORE

Resilient and agile engineering solutions to address coronavirus pandemic 575 views - 28 Aug 2020 ピュータン につうち デア DISLIKE から SHARE デキ SAVE ・・・・

Short course on Digitalisation and Industry4.0

- Delivered in 4 parts
- No registration required
- Watched 215 times on youtube by the community

Resilient and agile engineering solutions to address coronavirus pandemic

- COVID-19 related discussion
- Watched 667 times on youtube

11 October 2021

9:30 am - 12:30 pm, UK BST

<u>Register Here</u>

Joining information will be available upon registration. For further query or concern, please contact Pamila.Sharma@manchester.ac.uk

Tackling COP26 challenges using digitalised surface manufacturing

Introducing D	OSM and COP	and the second
09:30 am	Prof Allan Matthews, Director, DSM Network and The University of Manchester, UK	Thora is
	Welcome and Overview of DSM and its relevance to COP26	mere is
09:40 am	Ms Caaisha Warsame (1st year PhD Student), London South Bank University, UK	NO Panot
_	COP26 introduction	- INCI I Carreel
Speakers		
Energy system	ns	
09:45 am	Ms Laura Sandys CBE, Non-Executive Director, SGN Limited and Energy System Catap	uit, UK
Table a la service e	The Energy System of The Future- Digitalised, Decarbonised and Decentralised	
10:05 am	Dref Barbara Shelleck Kings College London LIK	
10.05 am	Prof Barbara Shollock, Kings College London, UK	
Nature inspir	ed engineering	
10.25 am	Prof Claus Helix-Neilsen DTU Denmark	
10.25 411	Biomimetic Membranes - surface engineering inspired by nature	and the second
	biominiette memoranes sandee engineering mopried by natare	
10:45 am	Short Coffee Break, 10 min	1 martine mart
Coatings for s	sustainable energy	the second state of the se
10:55 am	Prof Margaret Stack, University of Strathclyde, UK	
	A Weather-map, a Globe, a Wind-turbine and a Tidal-turbine: Some perspectives	
	on coatings selection for renewable energy systems	3 6 60
Thin films for	sustainable energy	2000 C
11:15 am	Dr Neil McSporran, NSG Group, UK	
	Future of Glass and Thin-film coatings	
Scalable low-	carbon manufacturing	A second of the second se
11:35 am	Mr Nicholas Butcher, Emerson and Renwick, UK	A set of the set of th
Student Dress	Industrial perspective on COP26	
11.55 am	Mr Nester Sanchez Arriaga, University of Sheffield, UK	A set of the set of th
11.55 am	Role of Instrumented Digital Platforms (Digitalisation) in Decarbonisation	A started by an end of the second started by
12.00 0000	Ms Sara Hawi Cranfield University LIK	and the second se
12.00 110011	Engineering Biology: Addressing one of the most threating impacts of climate change	
12:05 pm	Mr Sved Mehade Hussain, London South Bank University, UK	and the Destantion of the Street, and
Liss pin	Machine Learning: Future Developments for Sustainability and Tackling Climate Change	
Expert Panel		
12:10 pm	Q&A and Expert Panel Session	
12:30 pm	Close	

Events, Training courses and Other Engagements





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LEARN MORE

13 35 T DISLIKE A SHARE IN SAVE ...

COVID-19

675 views - 28 Aug 2020

Get the latest information from the NHS about coronaviru

Resilient and agile engineering solutions to address coronavirus pandemic

G See more resources on Google [2]

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Resilient and agile engineering solutions to address coronavirus pandemic

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Feasibility Awards- 2020 (Total 24 applications, 9 applications were funded for a total of £205,000)



University	PI Awarded/Title of the project (£25K)
Construction Construction Image: Construction of the state of the st	 Anil Prathuru, Andrei Petrovski, Nadimul Haque Faisal, Federico Venturi, Tanvir Hussain A machine learning based predictive tool for high velocity oxyfuel (HVOF) thermal spray coating performance and digitalisation
QUEEN'S UNIVERSITY BELFAST	Seán McLoone, Dan Sun, Emi Garcia-Palacios, Blesson Varghese, Pantekis Sopasakis, John McLoughlin Anodising, improve product and process
Loughborough	Manuela Pacella, Vadim Silberschmidt Innovative self-adapting materials for future coatings
MANCHESTER 1824 The University of Manchester	David Hall, Beatriz Mingo, Nicholas Bojdo Taking control of the aerosol deposition process for ceramic coatings
University of Nottingham	Tanvir Hussain, Federico Venturi, Acacio Rincon Romero A Machine learning tool for predicting sprayability and coating properties in Cold spray deposition (MaCSpray)

Feasibility Awards- 2021 (Total 24 applications, 9 applications were funded for a total of £205,000)



University	PI Awarded/Title of the project (Used IAA Funding Model for these)
Northumbria University NEWCASTLE	Prashant Agrawal, Matthew Unthank, Hamdi Torun, Richard Fu Modelling of integration of passive hydrophobic coating and active thin film Surface acoustic wave platform for effective bio-film removal
The University Of Sheffield.	Esther Karunakaran, Siddharth Patwardhan, Annette Taylor, Mahendra Raut Tailoring silica surfaces for antibacterial applications by application of surface interaction modelling: towards digitalising economical and scalable bio-safe surfaces
UNIVERSITY OF BIRMINGHAM	Nan Gao, Stefan Dimov, Navdeep Singh, Hassan Latif, Jitao Zhang Evaluating anti-biofouling properties of textured liquid-repellent surfaces using an experimental and Surface Evolver approach
LSBU UNIVERSITY OF CAMBRIDGE	Hari Upadhyaya, Gaurav Goel, Jonathan Bean Al designed Anti-Viral Surface Materials (ADAVSM)

ECR Engagement





▲ LIKE I DISLIKE A SHARE #+ SAVE ...

20 September 2021 ECR led COP26 Event

ECR led online event highlighting opportunities to tackle COP26 challenges

- 13 ECR speakers
- 6 UK Universities
- 30% PDRAs
- 70% PhD students
- 35% speakers female
- 85% speakers BAME
- 100% female speakers are BAME

Some examples of active support/Mentorship of ECR's

- DSMN+ organised a dedicated COP26 ECR event, which is a highly trending Youtube video. Through this event, ECRs from all around the UK showcase their viewpoints about the COP26 issue.
- DSMN+ Co-Director Dr Goel became an ECF Manufacturing Research member due to the active mentorship by the DSM team
- 3. DSMN+ supported Prof Hussain's EPSRC Fellowship on developing next generation spray coatings (Nottingham)
- 4. Of the 9 funded feasibility studies so far, 5 were led by ECRs
- There is now a new plan in place just discussed with EPSRC where DSMN+ and ECF forum will come together to do a joint event to seamlessly integrate the two vibrant communities
- 6. DSMN+ supported Dr Giusca's (Cranfield) Feasibility study bid awarded by the Metrology Hub

Collaboration with other organisations



HENRY ROYCE INSTITUTE









Innovations in Surface Engineering to achieve net zero by 2050



œrlikon



Collaboration with other Networks







Digitalisation for Sustainable Manufacturing- Joint Event- DSM+/UKMSN+ 21 July 2021 111 reses - Susamed ine on 21 Jul 2021 쇼마티 프로 Save ...

Organised a joint event titled-Digitalisation for Sustainable Manufacturing

Registration- 145 people Attended- 111

connected everything.

Outputs created by the Network of

Networks

Learning from Early Career Researcher survey in Spring 2021

A survey developed by the SPRITE+ network and includes responses from Early Career Researchers (ECRs) in the SPRITE+, eFutures and Connected Everything networks has helped shape our activities for ECRs. Please read the findings from the survey here.

Learning from the Network of Networks Community Equality, Diversity and Inclusion Survey 2021

The Networks came together over the summer of 2021 and over 260 people completed our survey so we can understand more about our community and how we can be more supportive, particularly as Covid restrictions ease. This is the summary and findings presented at the Network of Networks meeting in October 2021.

Network Impact

A discussion of the Network of Networks led to this summary document being created in November 2021. We hope this will help other networks consider their impact more widely than the typical outputs often measured.

Guide for Network Managers

For over 12 months a small group of network managers came together to share their learning and co-create a guide for managing networks based on their experience. The online guide was created by Dr Samantha Kanza and is hosted at Southampton University. Use this link to access the guide: network-mgmt.ai3sd.org/



The Security, Privacy, Identity and Trust Engagement NetworkPlus

SPRITE+ HUB

Security, Privacy, Identity, Trust in the Digital Economy

Dr Kieran McLaughlin (QUB), SPRITE+ Link



Transforming Foundation Industries Research and Innnovation Hub

finetwork+

TRANSFORMING THE FOUNDATION INDUSTRIES

AI 4 Scientific Discovery

Network

DSMN+ research footprint is growing

For example:

Der Springer Link

- 1. The network secured a £3.2million EPSRC grant to develop next generation selfsensing coatings (EP/T024607/1)
- 2. The network is contributing to Covid-19 research supported by the Royal Academy of Engineering
- 3. LSBU secured a feasibility project on Valorisation of Paper Mill Sludge to Manufacture Eco-Bricks Paper Mill from the tfi NetworkPlus (Sheffield)

Recent high impact papers with acknowledgement of DSMN+

Original Article Open Access Published: 26 October 2021 Role of thermal spray in combating climate change
V. Viswanathan, Nirmal Kumar Katiyar, Gaurav Goel, Allan Matthews & Saurav Goel 🖂
Emergent Materials (2021) Cite this article 542 Accesses 2 Altmetric Metrics
Abstract

Thermal spraying is a scalable surface engineering technique used to add or to restore functionality of a solid surface by applying a coating. Examples of this include protection against wear, erosion, abrasion, and heat. In a specific sense, thermal spraying is particularly used to deposit thermal barrier coatings (TBCs) which finds use in transportation, power generation and automotive sector. As being a surface technique, thermal spraying much like

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Volume 18, December 2020, 100356	Review Article Open Access Published: 30 July 2021
	Nature-inspired materials: Emerging trends and
Horizons of modern molecular dynamics	prospects
simulation in digitalized solid freeform	<u>Nirmal Kumar Katiyar, Gaurav Goel, Sara Hawi</u> & <u>Saurav Goel</u> ⊠
fabrication with advanced materials	NPG Asia Materials 13, Article number: 56 (2021) Cite this article
	5256 Accesses 3 Citations 7 Altmetric Metrics
S. Goel ^{A, S, S, S} 유 평, M. Knaggs ^D , G. Goel ^{A, D} , X.W. Zhou [*] , H.M. Upadhyaya [*] , V.K. Thakur ^{S, †} , V. Kumar ^B , Bizarri ^b , A. Trwari ^g , A. Murphy ^h , A. Stukowski [†] , A. Matthews [†]	G. Abstract
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https://doi.org/10.1016/j.mtchem.2020.100356 Get rights and conte	at a second s

materials, processes, or designs that we see around us. Materials, as opposed to processes and



Review | Open Access | Published: 09 July 2021

Emergence of machine learning in the development of high entropy alloy and their prospects in advanced engineering applications

Nirmal Kumar Katiyar, Gaurav Goel & Saurav Goel 🖂

Emergent Materials (2021) Cite this article 1303 Accesses 1 Altmetric Metrics

Abstract

The high entropy alloys have become the most intensely researched materials in recent times. They offer the flexibility to choose a large array of metallic elements in the periodic table, a combination of which produces distinctive desirable properties that are not possible to be obtained by the pristine metals. Over the past decade, a myriad of publications has inundated





Network Year 2 summary



- Followers/Members from 202 to 1396 (427+824+53+92)
- Partner organisations from 61 to 74 (In addition 5 EPSRC Networks)
- Enhanced digital interactions Network website / Twitter / LinkedIn / YouTube channela total of 36,000 interactions and 12,000 engagements, including about 4500 hours watched content on YouTube (viewed 2389 times)
- DSM Featured Webinar: Every Month, Increased flexibility
- 9 feasibility awards funded with a total of £205,000. Next ones will be in early 2022
- **79 one-to-one interactions with teams/PIs** (including a range of technical topics and a range of national, international, industrial, academic, ECR participants)
- Industry meetings to identify challenges for demonstrator projects



Thank you!







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www.digitalisedsurfacemanufacturing.com



