CNT INNOVATION

CAMBRIDGE NANOMATERIALS TECHNOLOGY LTD

nanoMAT 3D

Workshop on Nanomaterials for 3D Printing

Preliminary Programme

V2.0

Date: *13th October 2020*
Time: 08:30 – 12:30 (GMT)
Meeting Venue: ZOOM digital platform

Organisers: CNT Innovation SPRL/BVBA
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nanoMAT^{3D} - Workshop on Nanomaterials for 3D Printing

CNT Innovation in conjunction with its sister company, **Cambridge Nanomaterials Technology Ltd (CNT)**, are organising the **Nanomaterials for 3D Printing 2020 Workshop (nanoMAT^{3D})** in order to support commercialisation of use of nanomaterials in development of polymer and metal based composite technologies for additive manufacturing. The Nanomaterials for 3D Printing Workshop would be an opportunity to learn about progress in development of nanomaterials, new additive manufacturing technologies and progress in use of nanomaterials in additive manufacturing applications. It is also a platform to bring together technology development leaders and industrial end-users in order to exchange experience between technology developers in industry and researchers in academia working on nanomaterials and additive manufacturing. **Cambridge Nanomaterials Technology Ltd** held the 1st **nanoMAT^{3D}** in on the 10th -11th July 2019 at Wolfson College, in Cambridge, UK. Around 50 people participated in this workshop, coming from leading manufacturing and research organisations such as: ARUP, ArcelorMittal, Prysmian Group, RTE France, Mitsubishi Heavy Industries Europe, Additive Industries b.v. Aurubis, MBDA, Leitat Technological Centre, Eurecat, Coatema, E.G.O. Elektro-Gerätebau, Brunel Innovation Centre, TWI, Haydale, IMDEA and universities: National University of Singapore, University of Surrey, University of Cambridge and UCL, among others.

The **Nanomaterials for 3D printing Workshops** are designed as a platform to support nanomaterials and additive manufacturing producers, application developers and end-users, in development of technologies based on use of nanomaterials for 3D printing. The aim is to identify commercialisation barriers and opportunities and facilitate development of the supply chain.

Registration fees:	Registration form
Delegate Registration: **€150.00**	Registration form can be downloaded from the CNT Innovation's website: **www.cnt-innovation.com/nanomat3d_workshop/**

nanoMAT^{3D} Workshop on Nanomaterials for 3D Printing – Preliminary Programme

Please note that the event will start at 08:30 UK Time, it is currently planned to finished by 12:30. Detailed agenda with the timings will be produced as separate document, nearer the event.

- **Welcome and Introduction to the Nanomaterials for 3D Printing 2020 Workshop**

  Dr Bojan Boskovic, CEO, CNT Innovation & CNT Ltd.

- **Superhydrophobic surfaces achieved by soft atmospheric plasma polymerization: towards tunable wettability - Dr Claude Becker**, Mesa-Consult, Luxembourg

  Plasma polymer thin films are of great interest in surface engineering in a wide range of applications. However, all available technologies to achieve such surface modification are suffering from a lack of control in the plasma deposition conditions or are not adapted to industrial requirements in term of cost and production yield. MPG (Molecular plasma Group) company has developed an innovative deposition atmospheric plasma method, which can answer to all industrial criteria and could entirely fulfil their requirements. By using soft atmospheric plasma deposition conditions and by adapting these conditions to the used of suitable precursors [1], it appears possible not only to get a high retention of monomer functionalities but a polymerization close to conventional methods. Molecular investigation revealed the presence of polymeric moieties and the mechanism of plasma polymerization has been mainly based on the polymerization by activation of monomers specific chemical groups. This innovative plasma deposition technology affords not only to achieve high superhydrophobic surfaces (high contact angle values) but also to obtain a high control in the wetting regime (from Wenzel to Cassie Baxter state) on any kinds of substrates. With Molecular plasma□ technology, based on soft plasma polymerization method, we are able to control the wetting properties on a wide range of substrates, to immobilize numerous bio-molecules such as anti-bodies, DNA, proteins, peptides, etc. onto any substrate whilst keeping full bio-functionality. We can ensure perfect adhesion on the most inert substrates (Teflon, Carbon Fibre, Polyolefins, Titanium, …) as well as on the most sensitive substrates (Natural Fibres, Cellulose, Ultra-thin Films, …). And Because we are able to use a wide range of chemistry, many more surface functionalities are possible such as UV Barrier performances, temperature-controlled and reversible bonding, Gas-sensing capabilities, Fire retardant capabilities.

- **How the use of synchrotron characterisation can help addressing the grand challenges of Metals Additive Manufacturing - Dr. Ennio CAPRIA,** Deputy Head of Business Development, European Synchrotron (ESRF), France

  Additive manufacturing, often called 3D printing, represents one of the major innovations in the world of engineering and manufacturing. It is extremely promising because it offers the possibility to revolution the manufacturing industry with more cost-effective and environmentally friendly methodologies and definitely novel structures and designs. Nonetheless, AM is not yet largely adopted due to uncertainty around the performance and reliability of the final product.
  Exactly as in the case of laser welding, where a laser beam is responsible to melt materials in order to join parts, the additive manufacturing process involves the melting of metal powder using a laser beam, to create a 3D object. Very complex shapes and geometries are possible, as well as new materials, with potential applications in all industries from aerospace to automotive. However, differently from the normal manufacturing process, where the material can cool down and solidify in several seconds or minutes, in the additive manufacturing process the melting and cooling phases can be as fast as about 10 milliseconds, i.e.up to 1000 times faster. These extreme conditions can drastically affect the microstructure, and therefore performance, of the material. As a consequence, often, the properties of the material are not compliant with the specification and the tenure in time (fatigue) do not respect the predictions.

Synchrotron characterisation can offer a unique insight to better understand the AM related phenomena, in order to be able to design more efficient systems and materials. Synchrotron X-rays, with their very high flux can offer the possibility to see how the materials changes in real time. Images realised at a record speed of 1000 frames per second of the inside of the AM system, can allow to understand the exact dynamic of the material melting and solidification and of the powder dispersion. The researchers need this in order to see the real time effect of temperature at this timescale. Furthermore, high energy synchrotron X-rays diffraction methodologies can allow the possibility to measure local residual stress gradients that can offer a key for understanding the AM made parts performances, with respect to the manufacturing methodology and parameters, also in relation with the microstructure.

- **High Mechanical Strength Aluminium for Additive Manufacturing - Dr Maxime Delmée,** AM 4 AM, Luxembourg

  Additive Manufacturing (AM) is an emerging and proliferated worldwide technology for the processing of complex parts of a wide range of materials which cannot be processed by conventional manufacturing. This technology attracts the particular interest of the aeronautic and aerospace sectors. Although, some technological issues at the materials level have to be overcome to continue the expansion of this technology. Indeed, AM processes using high energy beam (laser or electron beam) still exhibit some major challenges especially when applied to metal or metal alloy powders. Only few metal or metal alloy powders out of the more than 5000 used in the industry can be additively manufactured nowadays. Amongst the main challenges, it can be pointed out the high reflectivity of metal powders, the oxidation of some alloys, the formation of microstructures with cracks, voids and defects and eutectic or peritectic decomposition of some alloys. Most aluminium alloys are not processable by additive manufacturing because of these limitations. AlSi10Mg is one of the only aluminium alloys processable by this technology but its mechanical properties are out of the specifications required by aeronautic manufacturers. High mechanical strength aluminium alloys own the potential to become one of the most sought-after materials in AM for aeronautic and aerospace applications. Indeed, aluminium thanks to its light weight and cheaper price compared to titanium and nickel superalloys attracts a lot of attention to replace heavier parts in aircrafts and helicopters. The ambition of AM 4 AM is to produce high mechanical strength aluminium alloy powder (similar to Al 7075 or 6061) for additive manufacturing and especially aeronautic, aerospace and automotive applications via an innovative technology. AM 4 AM filed a patent on powders modification by grafting of smaller particles on the surface of particles powder by atmospheric plasma discharge. This technology aims to produce high mechanical strength aluminium alloys crack free and fully dense structure with tensile strength around 500 MPa. AM 4 AM's technology aims at dispersing some small particles acting as grain refiner, nucleants, oxidation barrier onto the surface of conventional metallic powder to confer them additional properties and defects-free processability by additive manufacturing. The major principle is to inject directly particles and powders in the plasma discharge or in the downstream region, called afterglow region. The energy provided by the plasma will allow to disperse the particles onto the surface of powders. AM 4 AM first focus will be brought on the development of high mechanical strength aluminium alloy based on the functionalization of Al 7075 powder (50 – 70 µm) by zirconium hydride particles (1 µm) by plasma discharge. This treatment aims to reduce powders reflectivity, surface powder oxidation, cracks, voids and defects formation and eutectic or peritectic decomposition.

- **Hummink - Additive manufacturing at the nanoscale - Dr Amin M'BARKI,** CEO and Co-Founder, Hummink, France

  Hummink is a newly created spino7ff from ENS Paris and Institut Pierre Gilles de Gennes. After years of research and patenting in these academic institutions, Hummink develops a direct additive manufacturing technology, with unique versatility, precision, and resolution. Through direct deposition of various liquids (polymers, gels, colloids, Qdots...), you can design complex patterns with resolutions down to a few tens of nanometers. Hummink adresses the issue of freedom of design, with high versatility, in a resolution range that is very competitive, and allows

deposition of highly complex patterns. Semiconductor, molecular diagnosis, and the screen manufacturing are examples of markets that can benefit from our technology.

- **Concrete Large-Scale 3D Printing. A New Era in Construction and Architecture - Luis Clemente,** COO 3D Printing, Construction, ACCIONA, UEA

  3D Printing is a technology with potential to disrupt almost every single industry, and construction is not an exemption. As part of one of the less digitized sectors, construction companies are starting to find applications of advanced technologies such as Internet of Things, Artificial Intelligence, Augmented and Virtual Reality, Autonomous vehicles, Inspection Drones and 3D Printing.
  With infinite applications, materials and scales, 3D Printing can help the construction in many ways. One of them is the large-scale concrete 3D Printing which brings automation, freedom of shapes, safety, speed, sustainability and cost reduction as main advantages. Two main processes are applied for this, namely extrusion and powder-bed with applications in singular structures, sculptures and replicas, buildings, and urban furniture.

- *Panel Discussion - Facilitated by **Dr Bojan Boskovic**, CEO, CNT Innovation & CNT Ltd*

Note It is planned that all presentations would be followed by Q&A discussion. The organisers reserve the right to change the programme, speakers or venue should circumstances require. *For any further enquires please do not hesitate to contact directly Dr Bojan Boskovic on info@CNT-innovation.com or on his mobile phone +447780874335.*

nanoMAT^{3D} Workshop – Speakers

Dr Claude BECKER *(Speaker)*
MESA CONSULT
Luxembourg

Dr Claude BECKER is a senior scientist with an expertise based on the elaboration, functionalisation and the characterization of thin layers and materials surfaces. Since more than 15 years working for LIST (Luxembourg Institute of Science and Technology) organization, his activities were focused on the development of innovative equipment/devices and methods dedicated to thin layers deposition and surfaces modification. In 2016 he has founded MPG (Molecular Plasma Group), a company based in Luxembourg, which delivers a unique surface functionalization technology enabling solutions such as: superhydrophobicity and hydrophilicity, controlled release functionality oriented to aeronautic, automotive, microelectronic and packaging industries. He founded MESA CONSULT company in 2018 and has experience in consultancy services in material science and project management.

Dr Maxime *Delmée* *(Speaker)*
AM 4 AM
Luxembourg

Dr Maxime Delmée Maxime Delmée started his academic career at UNamur by obtaining a master in chemistry. During his PhD studies at the Luxembourg Institute of Science and Technology (LIST) and the University of Haute Alsace (UHA) he developed an innovative method to synthesize hybrid nanocoatings. He is a material scientist specialized in laser synthesis of nanomaterials and atmospheric pressure plasma treatment. He has published several papers in plasma and physical chemistry journals. Maxime Delmée is the founder and the CEO of AM 4 AM start-up, located in Luxembourg and dedicated to the development of new materials for additive manufacturing.

Dr. Ennio CAPRIA
Deputy Head of Business Development
European Synchrotron (ESRF)
France

Dr. Ennio CAPRIA gained his PhD in Applied Physics at Cranfield University (UK). In his research career he has worked on the development of nanobiosensors and on nanocomposites. In 2011 Ennio joined Elettra where he worked on manufacturing of optoelectronic devices and particularly their characterisation with synchrotron light. In 2013 Ennio joined ESRF as the IRT NanoElec Industrial Liaison Engineer and in 2016 became the Deputy Head of the BDO.

Dr Amin M'Barki *(Speaker)*
CEO and Co-Founder
Hummink
France

Amin M'Barki is the CEO and Co-Founder of Hummink. After a degree in chemical engineering at INSAT (Tunis), he graduated with Master (UPMC Paris) and a PhD in Material Science from the University of Lyon, were he worked on the additive manufacturing of bioinspired ceramics. He then pursued with a postdoc at ENS Paris, under the supervision of Lydéric Bocquet, on various scale up and industrialization topics.

Luis Clemente *(Speaker)*
Luis Clemente
COO 3D Printing
Construction
ACCIONA
UAE

Luis Clemente is a Civil Engineer highly committed to the innovation. He graduated in 2000 in Venezuela, where he was born. After 8 years working in construction projects as a Site engineer and Project supervisor, He moved to Spain to work in the R&D technology center of ACCIONA Infraestructuras. Throughout 4 years He was a manager in the Implantation area, taking those technologies been developed by the researchers to the sites and projects of ACCIONA as a link between R&D and production area. The most relevant job carried out during this period was as Site engineer of the world's first stress-ribbon type bridge using carbon fiber cables. After this, he was transferred to the Innovation area of the Corporate Division of ACCIONA. During this period, I worked on several innovation projects involving all the companies of the group, applying technologies of Mixed Reality and the development of ACCIONA's large-scale concrete 3D printing technology that was applied on the flagship project for the construction of the world's first 3D Printed concrete bridge. Most recently He supervised the launch of ACCIONA's new commercial solution for 3D concrete printing in Dubai, where He is currently the COO.

Dr Bojan Boskovic *(Speaker and Organiser)*
CEO,
CNT Innovation - Brussels
Cambridge Nanomaterials Technology - UK

Dr Bojan Boskovic is the Founder, Managing Director and Principal Consultant of the company. He has more than 20 years of hands-on experience with carbon nanomaterials and composites from industry and academia in the UK and Europe. Previously, he worked as a R&D Manager at Nanocyl, one of leading carbon nanotube manufacturing companies in Europe. He also worked on carbon

nanotube synthesis and applications as a Principal Engineer-Carbon Scientist at Meggitt Aircraft Braking Systems, as a Research Associate at the University of Cambridge, and as a Senior Specialist at Morgan Advanced Materials. During his PhD studies at the University of Surrey he invented low temperature synthesis method for production of carbon nanomaterials that has been used as a foundation patent for the start-up company Surrey Nanosystems. He was a member of the Steering and Review Group for the Mini-IGT in Nanotechnology that advised the UK Government on the first nanotechnology strategy policy document. Dr Boskovic was working as an advisor for the European Commission (EC) on Engineering and Upscaling Clustering and on setting up of the European Pilot Production Network (EPPN) and European Materials Charaterisation Cluster (EMCC). He has experience in exploitation and dissemination management on a number of FP7 and H2020 European projects, including UltraWire, NanoLeap, OYSTER, M3DLoC, Genesis and nTRACK. Also in UK Government InnovateUK funded projects, such as UltraMAT and GRAPHOSITE He is also a leader of two private consortium: Nano-Carbon Enhanced Materials (NCEM) and Advance Materials for Additive Manufacturing (AMAM).

nanoMAT^{3D} Workshop - Participating Organisations

Rolls-Royce plc.

Web: www.rolls-royce.com

Employing over 40,000 people worldwide, **Rolls-Royce** is a global company providing highly-efficient integrated power and propulsion solutions. Our power systems are predominantly used in aerospace, marine, energy and off-highway applications. We are one of the world's leading producers of aero engines for large civil aircraft and corporate jets. We are the second largest provider of Defence aero engines in the world. Rolls-Royce is well established in the marine sector where we design vessels and integrate power systems. We have a growing presence in civil nuclear power, drawing on our skills and experience of over 50 years in powering nuclear submarines. Our MTU brand is world-renowned in high-speed diesel engines powering applications as diverse as rail locomotives and luxury yachts.

The European Synchrotron Radiation Facility (ESRF)

Web: www.esrf.eu

The **ESRF** is the world's most intense X-ray source and a centre of excellence for fundamental and innovation-driven research in condensed and living matter science. Located in Grenoble, France, the ESRF owes its success to the international cooperation of 22 partner nations, of which 13 are Members and 9 are Associates.

MESA-CONSULT

Web: www.mesa-consult.eu/

MESA CONSULT is a Material Science & Engineering Consulting company, providing solutions to your new R&D challenges or product development. As a complement to your in-house ressources MESA CONSULT can assist your company in Advanced Materials manufacturing and characterization developed for a wide field of applications.

AM 4 AM

Web: www.am-4-am.com

AM 4 AM is a young start-up founded by Maxime Delmée. Activities of AM 4 AM are focused on the optimization of high mechanical strength aluminum alloy powders (similar to Al 7075 and Al 6061)

adapted to additive manufacturing needs especially in accordance with aeronautic, aerospace and automotive sectors requirements.

ACCIONA

Web: www.acciona-infraestructuras.es

ACCIONA is one of the foremost Spanish business corporations, leader in the development and management of infrastructure, renewable energy, water and services. Listed on the selective Ibex-35 stock exchange index, it is a benchmark for the market. The Company was set up over a century ago and is made up of more than 30,000 employees and has a presence in more than 30 countries on five continents.

CIC NanoGUNE

http://www.nanogune.eu/

NanoGUNE is a research center with the mission of performing world-class nanoscience research for the competitive growth of the Basque Country. NanoGUNE is a non-profit making Association promoted by the Basque Government in 2006. A Governing Board, currently composed by all partners, is the final responsible for the overall management of the center.

Vrije Universiteit Brussel

www.vub.be/en

Vrije Universiteit Brussel is an internationally oriented university in Brussels, the heart of Europe. Through tailor-made high-quality research and education, VUB wants to contribute in an active and committed way to a better society for tomorrow.

Richemont International SA

https://www.richemont.com/

Richemont was created in 1988 by the spin-off of the international assets owned by Rembrandt Group Limited of South Africa (now known as Remgro Limited). Established by Dr Anton Rupert in the 1940s, Rembrandt Group owned significant interests in the tobacco, financial services, wines and spirits, gold and diamond mining industries as well as the luxury goods investments that, along with the investment in Rothmans International, would form Richemont. Richemont owns several of the world's leading companies in the field of luxury goods, with particular strengths in jewelry, watches and writing instruments. Our Maisons™ encompass several of the most prestigious names in the luxury industry including Cartier, Van Cleef & Arpels, IWC Schaffhausen, Jaeger-LeCoultre, Officine Panerai, Piaget, Vacheron Constantin, Montblanc, Alfred Dunhill and Chloé. Richemont also owns leading online distributors YOOX NET-A-PORTER GROUP and Watchfinder & Co.

AIMEN Technology Center

Web: www.aimen.es

Laser-based manufacturing of metallic/non-metallic materials, including additive manufacturing, laser-coatings, laser-based surface functionalization, tailored made laser-surface treatment, multiphoton polymerization and laser-assisted forming. This also includes optomechanical design of laser head systems for beam profile shaping, spot variation, and multibeam combination. Flexible manufacturing for 0-defect system configuration through human-robot collaborative operation, augmented reality, development of intelligent adaptive manufacturing systems (monitored, CPS, reconfigurable and autonomous systems, embedded control systems, artificial intelligence), design and developing of

quality-based inspection systems, process control and tailored-based sensor monitoring. Development of structural and functional solutions based on high-performance and advanced materials involving mutimaterials systems, fiber reinforced polymer composites, cementitious/geopolymers composites, nanostructured light-alloys reinforced by nanoparticles dispersion.