SC3DP
Singapore Centre for 3D Printing

SEPTEMBER - DECEMBER 2025

NEWSLETTER

CHANGING THE WORLD THROUGH ADDITIVE MANUFACTURING

Professor Paulo Bartolo
Executive Director

MESSAGE

This Singapore Centre for 3D Printing (SC3DP) newsletter provides an overview of the diverse activities conducted by our research team from September to December. It reflects a year of opportunities and successes that we are pleased to celebrate with you, while fostering exciting prospects for sustainable growth and further consolidating SC3DP's position as a world leading hub for additive manufacturing (AM).

In a year marked by so much uncertainty and challenges across the industry, our achievements were remarkable regarding new projects and funding. It was SC3DP's most successful year so far, thanks to the support of our collaborators and technical staff. This period was also defined by a myriad of outreach activities, such as seminars and workshops and other relevant initiatives like our Open House and Appreciation Dinner, the 3D Printing Competition "Together We Print: SG60 Unity Challenge", and the 3D Photography Competition. We also showcase SC3DP at Formnext and ITAP, providing valuable opportunities to engage with industrial partners, initiate new collaborations, and further consolidate our leading position in publications across different AM areas. In addition, a large number of our members were once again listed among the World's Top 2% Scientists.

As we begin the Year of the Horse in the Chinese zodiac, I am confident that we will continue to move forward at a fast pace, with energy, enthusiasm, and strong support, while embracing new challenges and opportunities. I wish you a happy, healthy, and prosperous New Year.

HIGHLIGHTS

Exhibition 2025

- Formnext in Germany
- ITAP in Singapore Expo

3D Printing for Extreme Manufacturing

A virtual seminar by the International Journal of Extreme Manufacturing - The top-ranked journal in the field of manufacturing.

New Major Projects

- Cities of Tomorrow (CoT)
- NTU-CISRI (China Iron & Steel Research Institute) Advanced Additive Manufacturing Laboratory

SC3DP World's Top 2% Scientists 2025

43 SC3DP Researchers & Professors Earn Top 2% Global Recognition

NEWS

Research Collaboration with Germany

To strengthen research collaborations with leading organisations in Germany, SC3DP welcomed on 18 September **Professor Christoph Hermann**, Head of the Institute for Sustainable Manufacturing and Life Cycle Engineering, **Technical University Braunshweig and Fraunhofer Institute of Machine Tools and Production Technology**, and he was accompanied by members of his team. The meeting provided a valuable platform to enhance mutual understanding of each organisation's research activities. Several key collaboration areas were identified, paving the way for the establishment of future research partnerships.

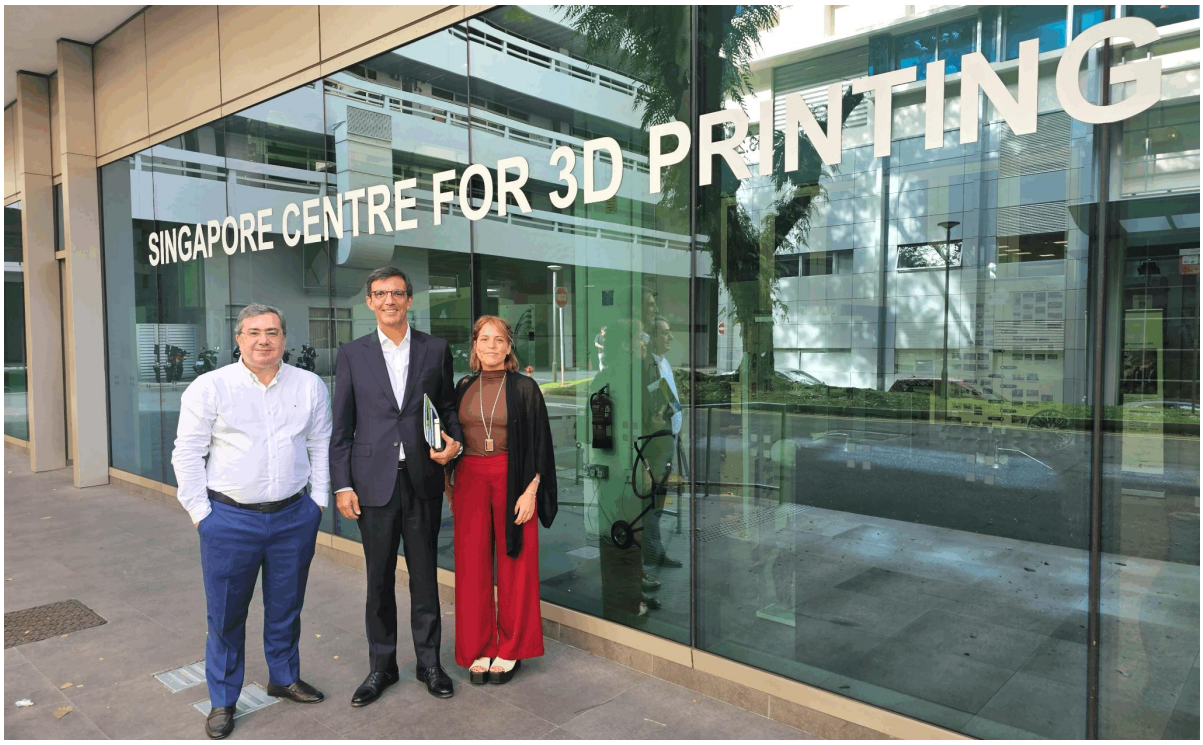
On 10 December, we met **Dr Eduard Ruge**, Science and Technology Cooperation, **Germany Embassy of Singapore**. The meeting provided an opportunity to introduce SC3DP research activities, relevant laboratories and current projects with Germany companies and research institutes, as well as to discuss new research and collaboration opportunities.

Research Collaboration with Germany (cont.)

Finally, a delegation from SC3DP visited the headquarter of **Leistritz AG** at Nuremberg. Founded in 1905, Leistritz has grown into a global technology group specialised in high-tech solutions across four main areas: turbine technology, pump technology, extrusion technology, and production technology. The company develops and manufactures precision components and systems used in industries such as aerospace, energy, automotive, plastics, chemical processing and pharmaceuticals. Leistritz employs around 2000 people worldwide.

During the visit, a **Research Collaboration Agreement** was signed focusing on advanced twin-screw extruders for additive manufacturing. The SC3DP delegation was hosted by **Mr Michael Everts** (CEO) and **Mr Sebastian Fraas** (Director, Process Applications).

Strengthening Research Collaboration between Singapore and Portugal



On 29 October, SC3DP hosted **Dr Francisco Pinheiro Catalão**, Director and Member of the Executive Board of AICEP (Agência para o Investimento e Comércio Externo de Portugal), Portugal Global, together with **Dr Rita Sansana,** Director of AICEP Singapore. The meeting focused on ongoing research activities between SC3DP and Portuguese organisations, as well as strategies to strengthen collaboration between Singapore and Portugal.

AICEP is the Portuguese Trade and Investment Agency, a public entity of the Government of Portugal dedicated not only to attracting foreign investment into Portugal but also supporting new projects and the internationalism of Portuguese companies.

Following the Memorandum of Understanding (MoU) signed in June**, Professor Lam Khin Yong** (Vice President, Industry) and Professor Paulo Bartolo visited the University of Porto, Portugal, from 1-3 December. During this visit, a **Research Collaboration Agreement** was signed, under which the University of Porto will fund a programme in additive manufacturing.

The visit also provided opportunities to engage with several Portuguese companies that would be associated with the partnership between SC3DP and the University of Porto. The delegation was hosted by **Professor António Sousa,** Rector of the University of Porto, and **Professor Rui Calçada,** Dean of the Faculty of Engineering at the University of Porto.

Insignia of the Portuguese Diaspora

On 19 December, Professor Paulo Bartolo, Executive Director of SC3DP was awarded the **Insignia of the Portuguese Diaspora in the presence of the President of the Portuguese Republic**, Professor Marcelo Rebelo de Sousa. This distinction recognised his merit, professional journey, and significant contributions to Portugal and its global diaspora. After being awarded the insignia, Professor Paulo Bartolo, reiterated his commitment to uphold and defend the interests of Portugal, while simultaneously strengthening bridges with Singapore through innovation and collaboration. He reaffirmed his unwavering commitment to actively promote the Portuguese Diaspora, and to carry out these responsibilities with ethics, independence, and a strong sense of public service, ensuring that both Portugal and Singapore mutually benefit from his dedication and leadership.

SC3DP World's Top 2% Scientists 2025

We are pleased to announce that **43 researchers from the Singapore Centre for 3D Printing** (SC3DP) were named in the 2025 World's Top 2% Scientists list by Stanford University and Elsevier. This significant recognition highlights the high calibre of research excellence at SC3DP. We extend our sincere congratulations to our distinguished researchers for their outstanding accomplishments, which further strengthen SC3DP's standing as a leading global centre for scientific excellence and innovation.

Source: https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/8

SC3DP Open House 2025

On 7 November, SC3DP organised its annual Open House 2025, welcoming visitors to explore the Centre's facilities, technical capabilities, and several groundbreaking research projects. The opening session featured keynote addresses by **Dr Yap Chor Yen** (National Additive Manufacturing Innovation Cluster, NAMIC) and **Dr Alex Liu** (ASTM International). Other speakers included **Mr Bertrand Floure** (Malvern Panalytical), **Dr Nellian Alagu Subramaniam** (Makino Asia), **Mr Surya Kumar** (Brightsun Marine), **Mr Sean Looi** (Creatz3D), **Dr Andri Riau** (Singapore Eye Research Institute) and **Mr Low Kar Perng** (Cellink). The session was attended by NTU's **Senior Vice President, Ms Tan Aik Na,** highlighting the significance of the event and its role in connecting academia and industry.

The event provided an excellent platform for SC3DP's partners, **Malvern Panalytical, ACME Equipment, Cellink, Creatz3D, ELH Tech, Makino, Kingly, and Polaris Science,** to showcase their capabilities and projects while engaging in discussion on the future of additive manufacturing. The event was attended by around 500 visitors, including members of the public, NTU affiliates and industry.

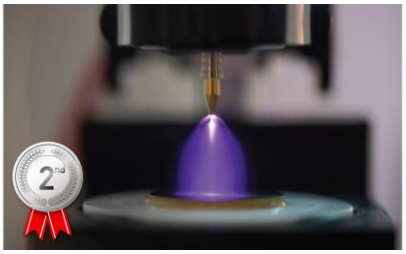
SC3DP Photography Competition

A photography competition was organised exclusively for members of the SC3DP community. The competition aimed to showcase the beauty and complexity of 3D printed structures through creative photography. Participants were encouraged to use various imaging techniques to capture either the intricate internal structures or the distinctive visual appeal of 3D printed parts.

The competition was launched in August, with judging conducted in October. More than 90 submissions were received, from which the top 15 photographs were selected and showcased during the Open House event.

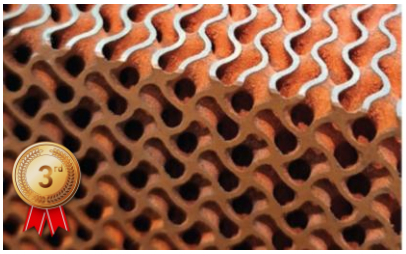
Photographer: Jorge Alfredo Estrada Diaz

The image depicts the e-jet printing of IZO for printed electronics. It resembles a shoreline observed from above that resemble fractal geometries, hence the title "Fractal Shores of Tomorrow Electronics.



Photographer: Ni Xiyao

It's the high voltage corona poling field captured via super long exposure.



Photographer: Shum Chee Wai

Artistic images to showcase the freeform beauty of 3D printing using different material.

Together We Print: SG60 Unity Challenge

The SC3DP 3D Printing Competition featured two themes - “Singapore: Past, Present & Future” and “Singapore as a Green and Sustainable Nation” - showcasing participants’ creativity, innovation, and technical expertise. Entries demonstrated diverse ideas, integrating electronic circuitry, fabrication, and assembly techniques while applying the key design principles to balance form, function and design.

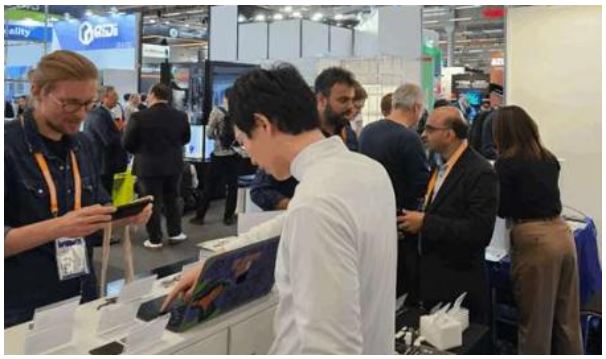
Participants came from a wide range of backgrounds, including polytechnics, universities, private companies, and the wider NTU community, highlighting the competition’s inclusive and multidisciplinary nature.

All submissions were showcased at the SC3DP Open House on 7 November at the NTU Innovation Port, where outstanding teams were recognised during the prize giving ceremony, followed by an interactive sharing session. SC3DP extends its heartfelt congratulations to all winners and participants for their outstanding contributions.

Top Three Winning Entries under the Theme: “Singapore: Past, Present & Future”.

Top Three Winning Entries under the Theme: “Singapore as a Green and Sustainable Nation”.

Formnext Expo & Convention - Where Ideas Take Shape

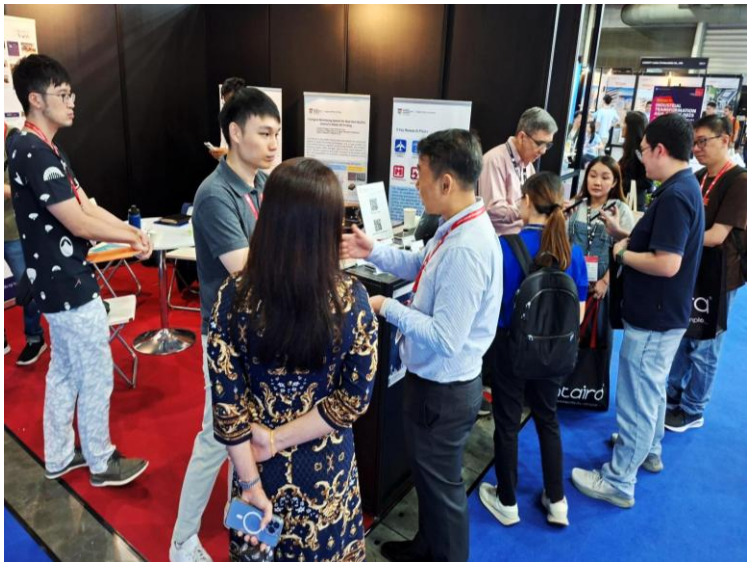
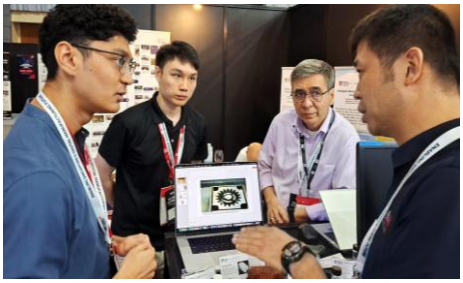


For the third consecutive year, SC3DP participated in Formnext (18-21 November), Frankfurt, Germany. Formnext is the leading global fair for additive manufacturing, focusing on industrial additive manufacturing, materials, software and smart manufacturing solutions. For SC3DP, Formnext provided SC3DP with an excellent platform to engage and connect with a wide range of stakeholders across the additive manufacturing ecosystem.

This edition, SC3DP highlighted the collaboration with **CELLINK** (Sweden) and **Nobula®** (Sweden) and the novel **LAPIS technology** being developed by our researchers. In an article published by 3D Print (https://3dprint.com/322294/formnext-2025-day-two-cost-out-lapis/amp/), **Mr Joris Peels,** Executive Editor, 3DPrint.com described LAPIS as **"The Best Thing That I've Seen in A Decade"**. For more information, visit https://lapis.sg.

Our booth attracted over 200 visitors, sparking in-depth conversations on emerging technologies and solutions for pressing industrial challenges.

Industrial Transformation ASIA-PACIFIC (ITAP) 2025


SC3DP participated in the Industrial Transformation ASIA-PACIFIC (ITAP) 2025 from 15-17 October. At the exhibition booth, visited by more than 100 companies, SC3DP showcased key projects and demonstrated the Centre's research technologies and capabilities. The event offered valuable opportunities to engage with industry partners and professionals. Professor Paulo Bartolo moderated the theme session, "Next-Gen Tech in Manufacturing: The Power of AI, Quantum Computing, 3D Printing & Mixed Reality". SC3DP's participation highlighted its continued leadership in advancing research and innovation in additive manufacturing.

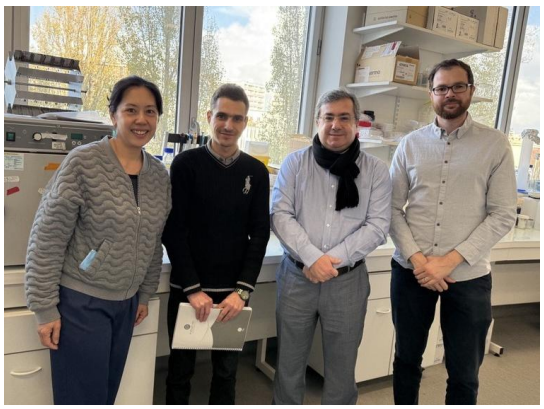
New Frontiers for Composite Printing

Following our visit to the Institute for Frontier Materials (IFM) at Deakin University, Australia, in July, we hosted a delegation led by **Professor Maryam Naebe** on 30 October. IFM is Australia's leading materials science research institute, with over 300 researchers and extensive industrial collaborations. The institute conducts research across areas such as advanced fibres and textile science, carbon fibres and composites, energy and battery materials, with a strong focus on sustainability, the circular economy and industrial impact.

During the visit, SC3DP and IFM held discussions on potential research projects and related activities to be incorporated into a major research collaboration agreement, which is expected to be signed in the near future.

RESEARCH PROJECTS

Fostering New Research Collaborations Across Europe



Following a recent trip to Nantes, France; Erlangen, Germany; and Budapest, Hungary on November, we have formally kicked off several new international collaborations through partner meetings, project discussions, and the signing of Research Collaboration Agreements (RCA).

In Nantes, we met colleagues from the **Nantes Université and National Institute of Health and Medical Research (INSERM)** to discuss the project "3D Bioprinting Biodegradable Skin Regenerative Wound Dressings" (3DBioReg), focused on the next-generation of secretome-releasing biodegradable wound dressings for improved healing outcomes. This project is funded by both National Research Foundation (NRF), Singapore and the French National Research Agency (ANR). During the meeting, a **Research Collaboration Agreement** was signed with **Professor Brigitte Dreno,** and the project's objectives were evaluated. Professor Paulo Bartolo also delivered a talk titled "Biomedical research @SC3DP". This initiative focused on the development of next-generation, secretome-releasing biodegradable wound dressings aimed at improving healing outcomes.

The Nantes Université, founded in 1961 is a large (around 42,500 students, including 1,300 doctoral students and 5,000 international students) multidisciplinary public university, known for its broad range of programs in science, health, humanities, and law, with campuses in Nantes, Saint-Nazaire, and La Roche-sur-Yon. INSERM (Institute National de la Santé et de la Recherche Médicale) is France's national public research organisation entirely dedicated to human health, bridging fundamental science with clinical applications to improve health outcomes through innovation, disease understanding, and public health research.

Fostering New Research Collaborations Across Europe (Cont.)

In Erlangen, together with **Professor Michael Schmidt** and colleagues from **Friedrich-Alexander University** (FAU) we launched the "Recycling Wood Waste and Parts for Sustainable Powder and Extrusion-Based Additive Manufacturing" (REWOOD-AM) project, exploring the use of wood waste for high-value additive manufacturing. This project is funded by the Singapore National Research Foundation (NRF) and the Federal Ministry of Research, Technology and Space (BMFTR). FAU, established in 1743 has 278 degree programmes, 40,996 students, 632 professors, and 3,655 researchers. The Institute of Photonics Technologies is a leader in photonics in medical engineering, additive manufacturing, ultrashort pulse technologies, joining technologies, and real-time sensing systems.

In Budapest, we were hosted by **Professor Jpzsef Vanza** at **HUN-REN Institute for Computer Science and Control** (SZTAKI), where we evaluated the progress of the ongoing project related to AI-driven bioprinting and discussed the application of AI to additive manufacturing, including opportunities for smarter process control and data-driven optimisation. Additionally, **Dr. Cian Vyas** from SC3DP presented a lecture on "3D Bioprinting: Bone to Cornea Tissue Engineering".

Founded in 1964, SZTAKI is the oldest and largest computer science institute in Hungary, with over 300 researchers. The institute pioneered research in basic and applied computer science, engineering, information technology, intelligent systems, process control, wide-area networking, and multimedia.

Cities of Tomorrow (CoT)

The Singapore Centre for 3D Printing (SC3DP) has been awarded a research grant under the Cities of Tomorrow (CoT) R&D Programme, funded by the National Research Foundation (NRF) and the Building and Construction Authority (BCA). The initiative is undertaken in collaboration with the Housing & Development Board (HDB) and, together with industry partners, to drive the development of innovative and scalable solutions for the built environment.

The project, a collaborative effort between SC3DP, CES_Innovfab Pte Ltd, and Hong Kong Polytechnic University, focuses on the development of an advanced 3D concrete printing system. The research project is structured around the following primary technical objectives:

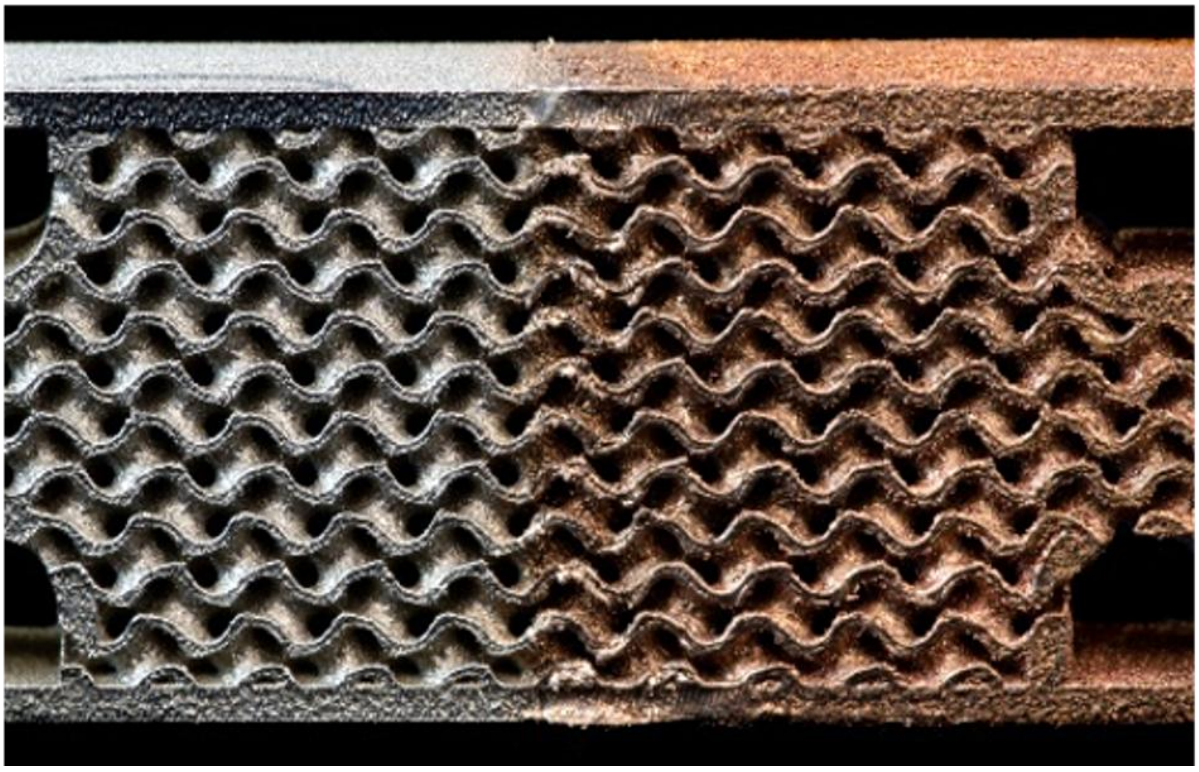
1. Multi-Agent Robotic Systems: Designing synchronised control for dual-bridge gantry printers, with the integration of mobile robots to optimise construction workflows.

2. Integrated Automation: Implementing robotic mechanisms for the seamless insertion of reinforcements, surface finishing, and the installation of MEP (Mechanical, Electrical, and Plumbing) fixtures to achieve a holistic construction approach.

3. Material and Digital Development: Advancing the performance of 3D concrete printing materials alongside digital tools and structural designs.

By integrating collaborative operations with 3D printing, this research aims to enhance the efficiency and scalability of automated building technologies.

NTU-CISRI (China Iron & Steel Research Institute) Advanced Additive Manufacturing Laboratory



This major research programme aims to develop a novel multi-material laser powder bed fusion (LPBF) system capable of printing up to five different materials without feedstock contamination. The system will integrate in-situ process monitoring and control, enabling real-time adjustment of printing parameters during fabrication to minimise or eliminate the need for support structures.

The research collaboration will also investigate the application of Hot Isostatic Pressing (HIP) to enhance mechanical properties and eliminate internal porosity in components for aerospace, marine and offshore, and medical applications. Leveraging the unique capabilities of the HIP system, the programme will further include activities to promote technology adoption among key industrial stakeholders in Singapore, supporting the translation of advanced powder bed fusion research into industrial practice.

ADDITIONAL PROJECTS

Besides the projects previously reported we started three additional projects: two NAMIC projects with ADDEPT3D (Feasibility study of multi-material deposition using wire arc additive manufacturing) and MEIBAN (Feasibility study of microfluidics channel printing); and one GAP Funded Project by NRF.

FEATURED SC3DP'S FACULTY

Professor Zhou Kun

- Associate Chair (Research), School of Mechanical and Aerospace Engineering
- Professor, School of Mechanical and Aerospace Engineering

Professor Zhou Kun's research focuses on the mechanics of additively manufactured metal and polymer materials and their industrial applications. He has published over 560 journal articles and five books (two authored and three edited), and his works have garnered more than 40,100 citations and an H-index of 97 on Google Scholar. He has been recognised as a Highly Cited Researcher by Clarivate in Cross-Field (2022 and 2023) and in Materials Science (2024 and 2025).

At SC3DP, Professor Zhou serves as Programme Director (Marine & Offshore). His group has advanced the development of high-performance alloys by integrating modelling at various length scales with powder bed fusion and directed energy deposition processes, leveraging insights into thermal transport, solidification dynamics, phase transformations, and deformation mechanics, thereby achieving performance beyond that attainable through conventional processing methods. To disseminate recent advances in the field, he co-authored the book *Metal Powder-Based Additive Manufacturing* (Wiley). His team has also developed multifunctional fibre-reinforced polymer composites by elucidating and tailoring process-structure-property relationships in powder bed fusion through interfacial engineering, controlled filler dispersion, and post-processing heat treatment.

Professor Zhou serves as Editor-in-Chief of *Journal of Polymer Materials*, Co-Editor-in-Chief of *Computer Modeling in Engineering & Sciences*, and Associate Editor or Editorial Board Member of several international journals, including *Virtual and Physical Prototyping.* He has also served as a Guest Editor for numerous special issues on additive manufacturing in leading journals, including *Advanced Materials, Materials Science and Engineering: R: Reports*, and *Materials Today.*

Professor Zhou was elected a Fellow of the European Academy of Sciences and a Member of the European Academy of Sciences and Arts. He was also elected a Fellow of the American Physical Society, the Institute of Physics (UK), the Institution of Mechanical Engineers (UK), the Royal Aeronautical Society (UK), the Royal Society of Chemistry (UK), and the Institute of Materials, Minerals & Mining (UK). In recognition of his contributions at the intersection of mechanics and additive manufacturing, he was awarded the 2026 J. N. Reddy Medal (MAMS).

Professor Gan Chee Lip

- Vice Provost (Undergraduate Education), President's Office
- Dean, NTU Honours College
- Executive Director, Office of Research & Technology in Defence & Security (ORTDS)
- Professor, School of Materials Science & Engineering, College of Engineering

One of Professor Gan's research interests is on 3D printing of advanced ceramics. His research focuses on developing ceramic pastes, optimising printing processes, and enhancing the mechanical and optical properties of printed ceramic materials. His team has developed the 3D printing of transparent spinel ceramics using stereolithography (SLA) that exhibits high transmittance and high hardness, suitable for optical windows, lenses, and photocatalyst supports in harsh environments. His team has also 3D printed high thermal conductivity and high strength silicon nitride lattice structures, suitable for automotive engine parts, ball bearings, heat exchangers and structural supports for space telescopes. The team also holds patents in the 3D printing of other ceramics such as silicon carbide, zirconia and YAG (Yttrium Aluminium Garnet).

VISITOR

Professor Bárbara Gouveia

- Faculty in the Department of Mechanical Engineering of Instituto Superior Técnico (IST), University of Lisbon (UL), Portugal
- Researcher at the Institute of Mechanical Engineering (IDMEC), integrated in the Associated Laboratory for Energy, Transport and Aeronautics (LAETA), Portugal

Bárbara Gouveia is a faculty member of the Department of Mechanical Engineering at Instituto Superior Técnico, University of Lisbon, Portugal. She began her academic career focusing on metal manufacturing processes. Since 2010, her research work was on additive manufacturing and, in particular the fabrication of biomaterial scaffolds for bone tissue regeneration. Later, she expanded her work to the design of porous structures, particularly triple periodic minimal surface (TPMS) designs, investigating the relationships between permeability, porosity, and mechanical properties, as well as conducting experimental and numerical analyses of elastomeric components for energy absorption.

Currently, she is conducting research on 3D printing of metal lightweight lattice structures and the correlation between printing conditions, lattice design and mechanical performance. She has contributed to numerous national and European research projects and maintains strong industry collaborations through consultancy in process optimisation, tooling design, and material characterisation. In addition, she played an active role in academic governance, serving at the Executive Committee of the IST Department of Mechanical Engineering, as well as Deputy Coordinator of the Manufacturing and Industrial Management area.

As part of her sabbatical, Professor Bárbara Gouveia spend there months at SC3DP doing research in the field of high-speed directed energy deposition.

INTELLECTUAL PROPERTY

4 New Technology Disclosure (TD)

- TD 2025-218: "Modular Multi-Model 3D Food Printer", Kunj Sachdeva, Paulo Jorge Da Silva Bartolo, Patricia Conway, Stefan Wuertz and Ng Wei Long
- TD 2025-366: "Adaptive Thermal Image Enhancement and Temperature Mapping Pipeline using Classic and Deep Learning Methods", Aryan Dutt, Shubham Chandra, and Paulo Jorge Da Silva Bartolo
- TD 2025-482: "Integrated Optimization of Formulation, Process and Sintering Parameters for Stereolithography-based Fabrication of SiC Ceramics", Wei Zaixin, Du Zehui, Gan Chee Lip
- TD 2025-486: "Real-time evaluation of surface roughness and periodic surface patterns in WAAM using thermal gradient analysis", Tuan Tran

PUBLICATIONS

In 2025, **SC3DP's researchers published a total of 117 papers in leading journals** such as Progress in Materials Science (***Impact Factor: 40.0***), Materials Science and Engineering R (***IF: 26.8***), Advanced Materials (***IF: 26.8***), Materials Today (***IF: 22.0***), International Journal of Extreme Manufacturing (***IF: 21.3***), Applied Catalysis B Environmental and Energy (***IF: 21.1***), Advanced Functional Materials (***IF: 19.0***), ACS Nano (***IF: 16.1***), Nature Communications (***IF: 15.7***), Journal of Materials Science and Technology (***IF: 14.3***), Advanced Science (***IF: 14.1***), Interdisciplinary Medicine (***IF: 13.6***), Chemical Engineering Journal (***IF: 13.2***), Science Advances (***IF: 12.5***), Engineering (***IF: 11.6***), Additive Manufacturing (***IF: 11.1***), Materials Futures (***IF: 10.8***); Journal of Cleaner Production (***IF: 10.0***).

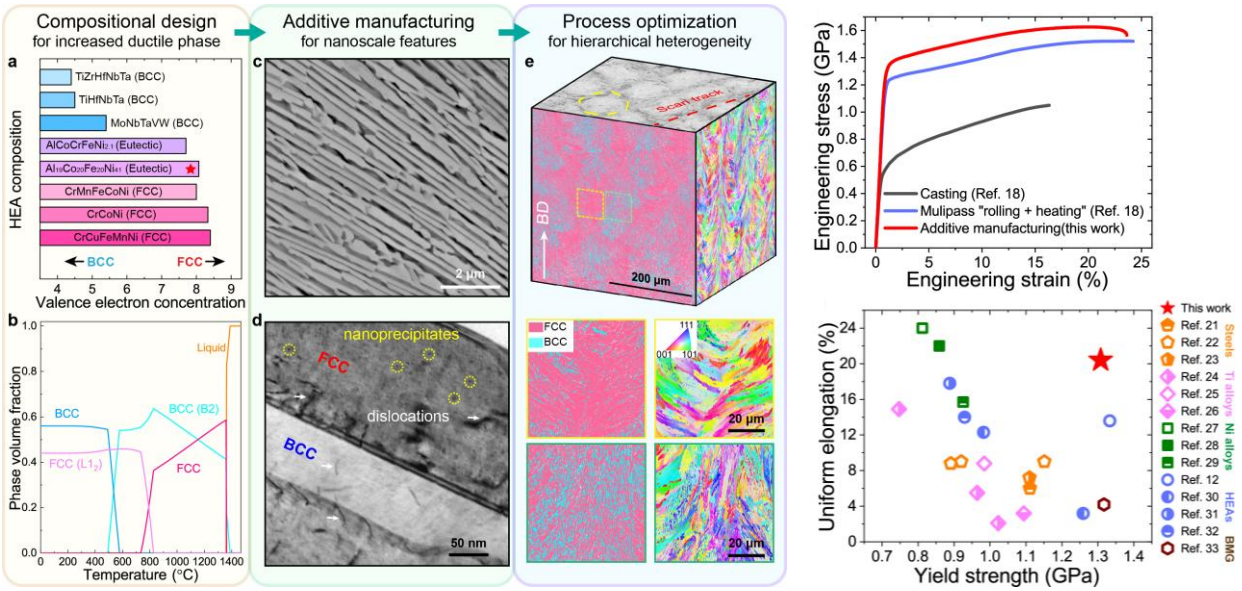
86 papers (73.5%) have co-authors affiliated to international organisations. **41%** of the papers have co-authors from **China**, **12%** of the papers have co-authors from **UK**, **9%** of the papers have co-authors from **South Korea** and **7%** of the papers have co-authors from **United States of America**

Overall, SC3DP remains as the leading university research centre in terms of publications in the field of **3D Printing/additive manufacturing** (overall position: 31; leading organisation: Ministry of Education of the People's Republic of China). It is also the leading university research centre in terms of publications in specific areas related to 3D Printing/additive manufacturing such as **bioprinting** (overall position: 20; leading organisation: Harvard Medical School), **4D printing** (overall position: 16; leading organisation: Ministry of Education of the People's Republic of China), **concrete printing** (overall position: 11; leading organisation: Tongji University), **laser metal printing** (overall position: 12; leading organisation: Ministry of Education of the People's Republic of China)

RESEARCH HIGHLIGHTS

Unveiling the Mechanisms of Strength-Ductility Synergy in an Additively Manufactured Nanolamellar High-Entropy Alloy

Professor Zhou Kun



Introduction:

The combination of alloy design and advanced manufacturing techniques inspires solutions to critical engineering challenges, such as simultaneously achieving high strength and high ductility in structural alloys. Eutectic high-entropy alloys (EHEAs) are particularly promising for their integration of both strong and ductile phases. Here, using valence electron concentration as a criterion, we employ laser powder bed fusion (L-PBF) to fabricate $Al_{19}Co_{20}Fe_{20}Ni_{41}$ EHEA with a nanolamellar microstructure, chosen specifically for its increased fraction of ductile face-centred cubic phase. The EHEA processed by L-PBF exhibits high yield strength exceeding 1.3 GPa together with a large uniform elongation of 20%. This strength-ductility synergy arises from the coherent nanoprecipitates, nanolamellar structures, hierarchical microstructure heterogeneity, and deformation-induced nanovoids activated within the hard body-centred cubic lamellae.

Key Highlights:

- **As-printed EHEA with outstanding strength-ductility**: yield strength of 1311 MPa, ultimate tensile strength 1630 MPa, uniform elongation 20%
- **AM-enabled hierarchical heterostructure**: nanoscale FCC/BCC lamellae plus mesoscale BCC-rich/BCC-lean "brick" architecture

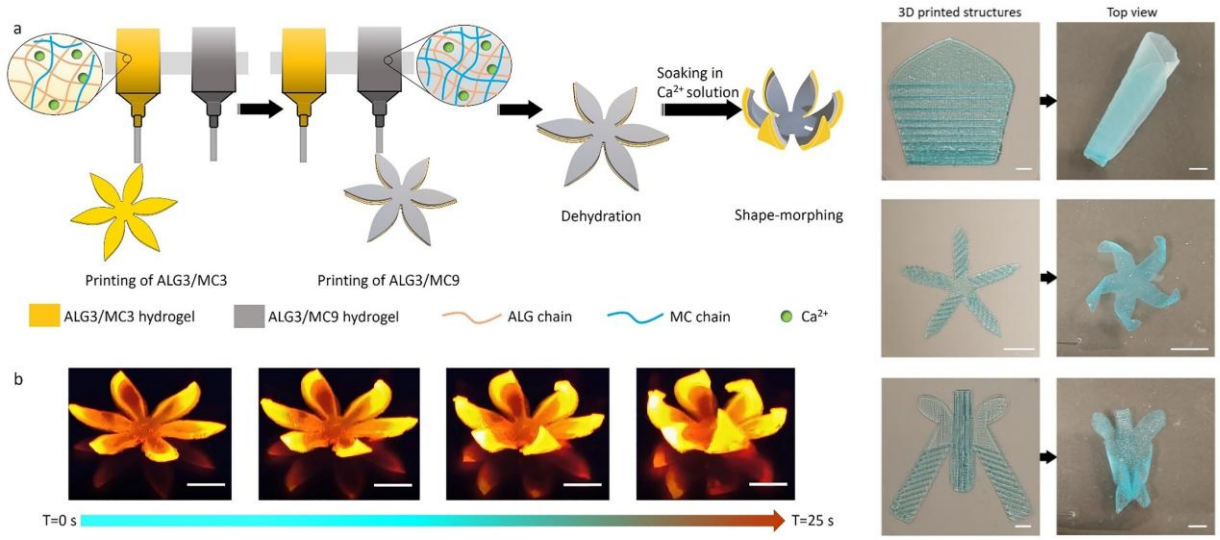
Conclusion:

The strategy presented in this work provides a cost-effective approach for fabricating high-value alloy components and can be readily extended to the design of other dual-phase HEAs or heterogeneous metallic structural materials that require geometrical complexity and scalable manufacturing.

Source: Gao, S., Ji, W., Zhu, Q., Jarlöv, A., Bai, X., Shen, X., Liu, Y., Nai, MLS., Gao, H., Zhou, K. *Nature Communications,* 16(2025). https://doi.org/10.1038/s41467-025-64871-4

Direct 4D Printing of Hydrogels Driven by Structural Topology

Professor Zhou Kun, Professor Paulo Bartolo



Introduction:

4D printing of hydrogels is attractive for constructing shape-changing soft structures; however, achieving complex, high-fidelity geometries remains challenging due to the limited printability of hydrogels. This paper proposes a direct ink writing (DIW)-based 4D printing strategy that integrates highly viscous hydrogels with structural topology design, enabling filament spacing and orientation program gradient swelling and shape morphing in a Ca^{2+} solution. It also shows that enhancing printability (e.g., with MC or PVA) expands the library of the hydrogel applicable to 4D printing, demonstrated across ALG/MC, GelMA, and ALG/PVA, with plant-inspired morphing examples targeting biomimetic soft robotics.

Key Highlights:

- **Direct 4D printing via "viscosity + topology":** highly viscous inks combined with pre-designed patterns to enable programmable morphing.
- **Printability is a gatekeeper:** low-fidelity ALG patterns fail to morph effectively, whereas GelMA and ALG/PVA retain designed features and exhibit the intended morphing behavior.
- **A general and practical route to expand material choices:** incorporating viscous additives (MC/PVA) enhances printability and enables morphing across both synthetic and natural hydrogels.

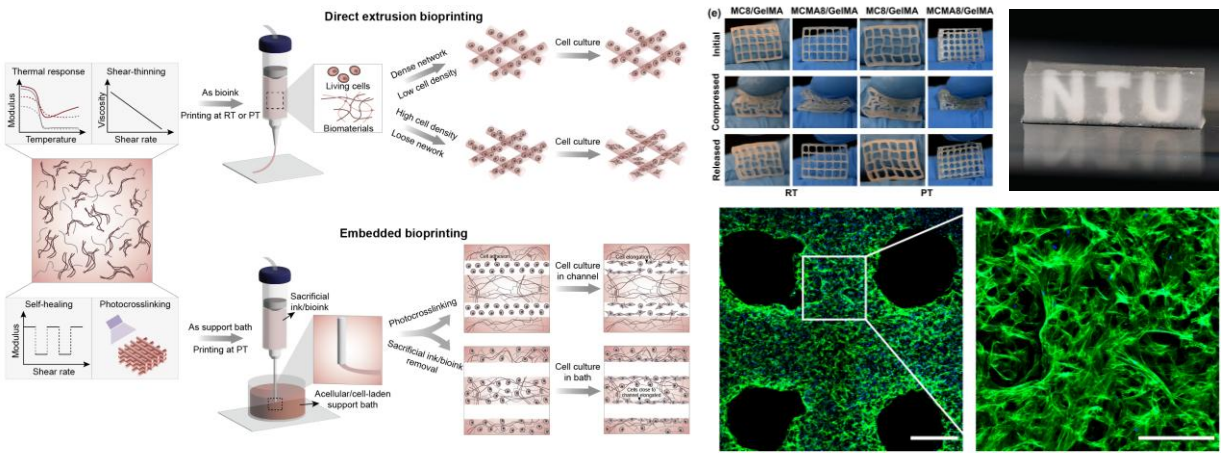
Conclusion:

This work presents an efficient strategy for direct 4D printing of hydrogels by combining highly viscous inks with intricate structural designs to achieve programmable shape-morphing. The approach is material-general (validated in ALG/MC, GelMA, ALG/PVA), and highlights a practical control parameter - viscosity enhancement via MC/PVA - to "rescue" low-printability hydrogels, thereby enabling complex, biomimetic transformations relevant to soft robotics and other soft devices.

Source: Li, H., Bartolo, P. J. D. S., Zhou, K. *Virtual and Physical Prototyping*, 20 (2025).
https://doi.org/10.1080/17452759.2025.2462962

Dual Crosslinkable Bioink for Direct and Embedded 3D Bioprinting at Physiological Temperature

Professor Paulo Bartolo, Dr Huang Boyang, Dr Cian Vyas



Introduction:

This study reports a dual thermoresponsive and photocrosslinkable GelMA-methylcellulose platform designed to enable both direct extrusion and embedded 3D bioprinting at physiological temperature (37 °C). This addresses a common trade-off where bioinks become low-viscosity (cell-friendly) but lose print fidelity at 37°C. Combining GelMA with MC or MCMA creates a semi-interpenetrating/interconnected network whose temperature-dependent rheology (gel-sol-gel) provides extrusion-friendly shear-thinning plus self-healing support-bath behaviour at a broad range of temperatures, and then “locks in” structure via photocrosslinking.

Key Highlights:

- Bioprinting temperature-dependent printability window broadened due complementary rheological behaviour of methylcelluose and gelatin.
- Quantified extrusion printability across broad temperature range 18-37°C.
- Mechanically tuneable and dual-crosslinked hydrogel platform suitable for a range of tissue applications and biofabrication strategies.
- Support bath performance at physiological temperature enables embedded bioprinting of complex features and perfusable channel networks after sacrificial ink removal.
- Cell viability improves at 37°C and the bioink support high cell densities.

Conclusion:

Overall, the study presents a versatile, physiological temperature-compatible bioink/support-bath that expands extrusion and embedded bioprinting capability to 37°C, whilst highlighting an important design constraint: rheology/printability gains from higher MC/MCMA can reduced cell spreading and growth, implying that composition, crosslink density, and cell density must be tuned for tissue-specific applications.

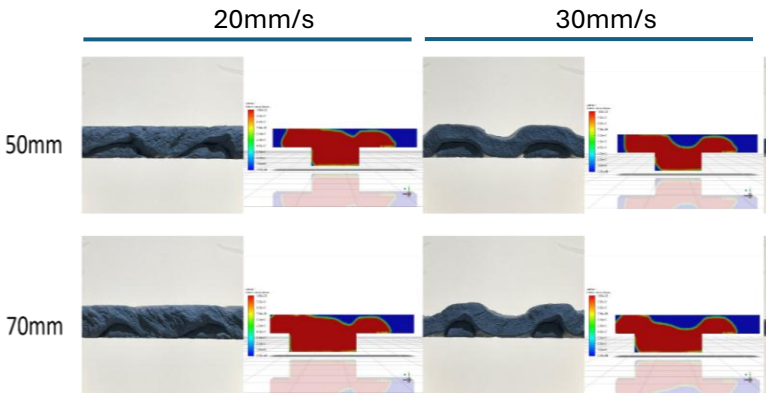
Source: https://doi.org/10.1016/j.mattod.2025.02.005

In-Process Filament Repair in 3D Concrete Printing with Instance Segmentation

Professor Ming Jen Tan, Associate Professor Teck Neng Wong, Associate Professor King Ho Holden Li
Assistant Professor Yi Wei Daniel Tay, Dr Ming Yang Li, Dr Zhi Xin Liu, Dr Tan Kai Noel Quah

Introduction

3D Concrete Printing (3DCP) stands as an automated method using robotics to construct concrete structures layer by layer, offering time efficiency, cost savings, and improved safety. Despite its practical relevance, on-site operators are still necessary to identify printing issues. While research focuses primarily on material optimization, lesser attention is given to processing, software, and building integration aspects. This study delves into the gaps and correction behavior of 3DCP cementitious materials, employing simulation tools and computer vision. Using varied nozzle speeds (60mm/s, 30mm/s, and 20mm/s), repairs were attempted above simulated gaps on the base layer. Assessing real-time in-process scanning and repair for a closed-loop system proved promising, though hardware limitations introduced unforeseen noise. Future work suggestions encompass improved simulated models, nozzle travel speed optimization, enhanced inference models for higher layers, and nozzle adaptations for smaller repairs.



Experimental (left) and simulated (right) in-process filament repair profiles at nozzle travel speeds of 20 mm/s and 30 mm/s for gap sizes of 50 mm and 70 mm.

Key Highlights:

- The paper proposes an in-process restoration strategy for 3DCP that allows interrupted prints to be resumed without initiating reprints.
- It identifies and categorizes different interruption scenarios (e.g., early-, mid-, and late-stage pauses) that link to specific restoration requirements and interface quality concerns.
- Experimental results show that appropriately designed restoration protocols can recover a substantial portion of defect propagation, although visually evident.
- Guidelines and limitations for applying in-process restoration in real-world 3DCP projects emphasize the need for standardization and long-term durability studies.

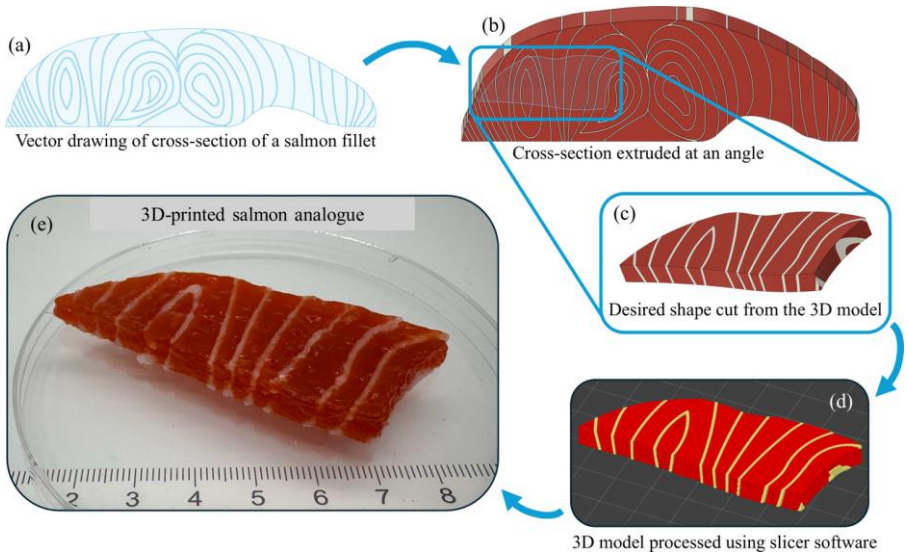
Conclusion

This study displayed the novel Next-Layer Delivery (NLD) methodology for in-process repair in 3DCP and has highlighted the importance and complexity of process control and automation, specifically focusing on nozzle travel speed adjustments and their impact on repair efficacy. The findings underscore that real-time in-process scanning and autonomous repair is realistic and highly promising for a fully autonomous 3DCP process.

Source: https://doi.org/10.1080/17452759.2025.2544758

3D Printing of Salmon Sashimi Analogues Using Fish-Derived Food inks

Dr Wei Long Ng (Presidential Postdoctoral Fellowship Project)



Introduction:

While sashimi is a globally popular delicacy, raw fish consumption carries risks of parasites and foodborne illnesses. Existing plant-based alternatives often lack complete nutritional profiles and fail to replicate the delicate, smooth texture of raw salmon. This study utilizes fish gelatin as a base matrix due to its high digestibility and almost complete amino acid profile. By combining it with gellan gum, a robust hydrogel network is formed, which can be 3D printed with high precision to create salmon analogues that mimic the visual and textural attributes of raw salmon without post-processing.

Key Highlights:

- The inks demonstrated strong shear-thinning behaviour (conformity to the Ostwald-de Waele model, R^2 >0.95), which is essential for smooth flow during extrusion and rapid structural recovery post-printing.
- Incorporating gellan gum significantly elevated the gel-to-liquid transition temperature, allowing the 10-1 formulation to maintain structural integrity at physiological body temperature of 37°C.
- Among nine tested formulations, the 10-1 gelatin-gellan gum ink exhibited textural properties closest to raw salmon, successfully replicating its unique mouthfeel.
- The 10-1 formulation retained ~44% of the protein content and 22.7% - 46.8% of the amino acid profile (excluding tryptophan) found in raw salmon.
- Using multi-material 3D printing, the team fabricated constructs that replicate the intricate red-and-white layered patterns (myomeres and myosepta) of salmon sashimi.

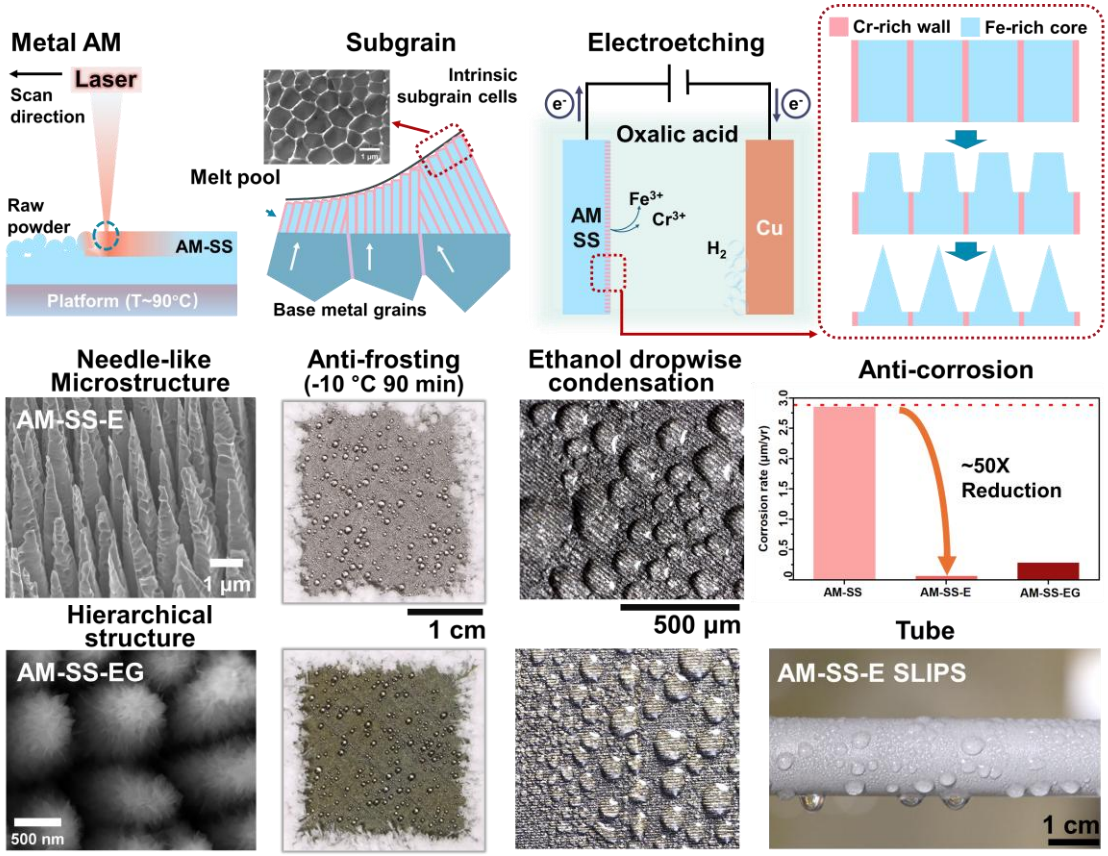
Conclusion:

This research advances 3D food printing by providing a customizable solution for high-resolution, nutritionally enriched seafood analogues. The developed edible scaffolds offer a stable platform for future integration with cultivated cell extracts, which could further enhance the realism, flavour, and nutritional density of alternative seafood products.

Source: https://doi.org/10.1007/s11947-025-03943-1

Ultrascalable Hierarchical Micro/nanostructures on Additively Manufactured 316L Stainless Steel for Multifunctional High-Performance Interfaces

Assistant Professor Jin Yao Ho, Dr Xinrui Wang



Introduction:

Additive manufacturing offers geometric freedom, yet the lack of scalable surface engineering strategies continues to limit interfacial performance in corrosive, humid, and freezing environments. This work leverages intrinsic AM microstructures with targeted surface chemistry and enables multifunctional interfaces without compromising manufacturability.

Key Highlights:

- Selective removal of SLM-fabricated SS316L (AM-SS) subgrains creates new microneedles.
- Extreme low water adhesion achieved by hierarchical AM-SS with additional oxidation.
- The new surface reduces corrosion rate by 98% and resists frosting down to -15°C.
- Enables stable dropwise condensation of low-surface-tension fluids for the first time.
- Micro/nanostructuring technique demonstrated on meter-scale tubes.

Conclusion:

A scalable electrochemical strategy is developed to form hierarchical micro/nanostructures on AM SS316L with ultra-low droplet adhesion. Mechanistic insights into oxalic-acid electroetching show that optimized conditions generate dense needle-like microstructures, while FeO(OH) nanosheets further construct robust hierarchical structures. The resulting surfaces achieve ~50× corrosion-rate reduction, delay frosting to -15°C, and stable dropwise condensation of low-surface-tension fluids, demonstrating multifunctionality for advanced AM-enabled thermal and interfacial applications.

Source: https://doi.org/10.1016/j.cej.2026.172691

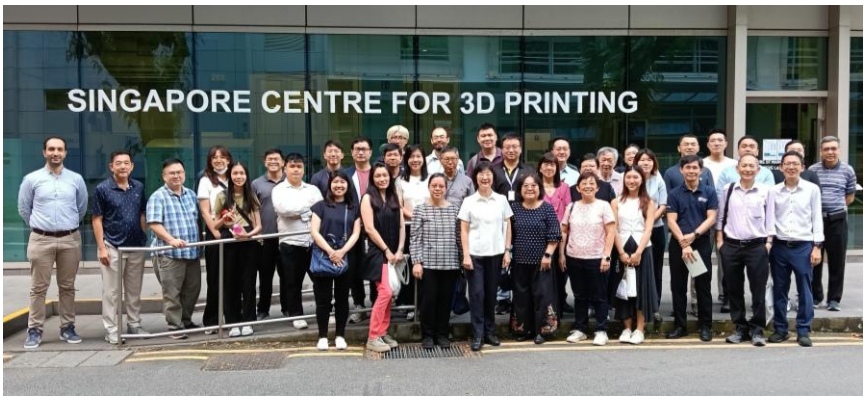
WORKSHOPS AND SEMINAR

Innovations in Biohybrid and Medical Robotics

SC3DP hosted a delegation from the **Shanghai Jiao Tong University School of Medicine** on 12 December. Discussions focused on "Innovations in Biohybrid and Medical Robotics" and the progress of ongoing projects.

Invited speakers **Dr Shaoping Huang**, **Dr Xing Lai**, and **Dr Liping Ouyang** presented their research on surgical robotics, biohybrid systems, and advanced medical technologies. The session facilitated in-depth academic exchange and highlighted potential avenues for future collaborative research. SC3DP looks forward to further strengthening its partnership with Shanghai Jiao Tong University in the areas of medical robotics and biomedical innovation.

Exploring the Future of Construction with HDB (Housing & Development Board)



On 1 December, SC3DP welcomed participants from the **Housing & Development Board** (HDB) led by Director (Chief Civil & Structural Engineer) **Er Teh Poh Suan** for a seminar that provided valuable insights into the future of construction. The technical session featured several engaging topics, beginning with an opening presentation by our Programme Director **Associate Professor Wong Teck Neng**. Participants got a better understanding on how the integration of advanced 3D printing technologies with automation was poised to revolutionise the building and construction industry.

During the lab tour, the HDB team explored how digital and robotic fabrication methods, as well as the development and application of sustainable materials, are reshaping manufacturing practices.

Seminar - Hungarian Research Network (HUN-REN)

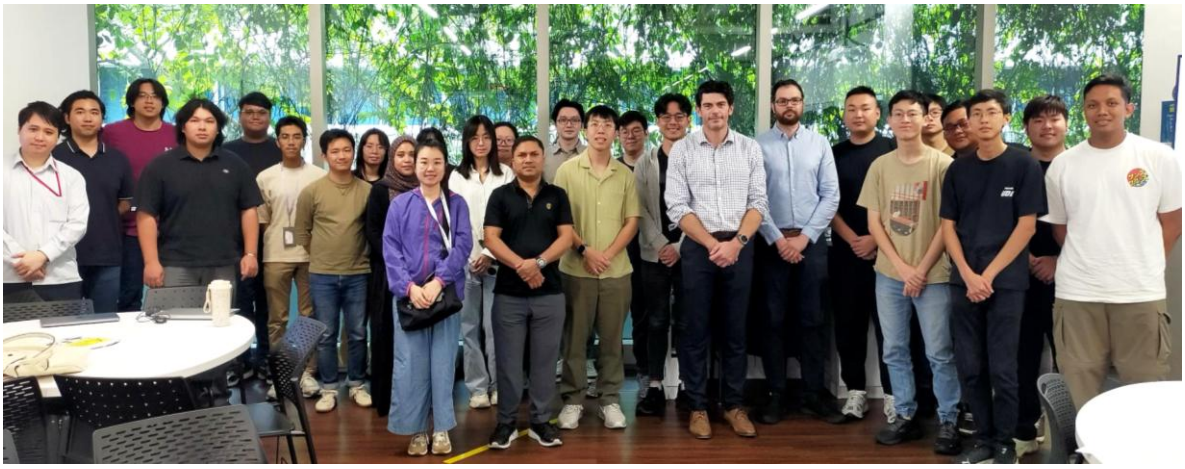
On 10 October, SC3DP hosted two engaging talks on recent advances in industrial robotics and intelligent control. On the topic “Generic Solver for Process Planning and Sequencing in Industrial Robotics”, **Dr. András Kovács** introduced ProSeqqo, a unified solver that streamlines robotic process planning and task sequencing, replacing many custom TSP (Traveling Salesman Problem) - based methods. The tool was made available as open-source on GitHub.

Dr. Balázs Csanád Csáji presented “A Sampling-and-Discarding Approach to Stochastic Model Predictive Control”, a new Stochastic Model Predictive Control (SMPC) method that handles uncertainty using a generative model and offers distribution-free guarantees. A renewable energy case study demonstrated its practical value. The talks offered useful insights into emerging methods , shaping the future of robotics and control technologies.

Experiential AM (Additive Manufacturing) Tour

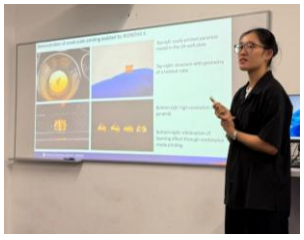
As part of the Singapore Additive Manufacturing Week, supported by NAMIC (National Additive Manufacturing Innovation Cluster), SC3DP hosted an Experimental AM Tour (13 October). The guest speaker, **Mr Adam Hourigan** from Meltio, Spain, delivered a talk on “Wire-Laser Metal 3D Printing”, providing a large number of highly relevant industrial cases. At the end of the workshop, participants (including a large number from industry) visited SC3DP’s facilities, and attended several lab demonstrations.

Insights in Hybrid Additive Manufacturing of Advanced Functional Materials



On 15 October, **Professor Robert Kay** from the University of Leeds, UK, delivered an engaging talk on the fabrication of functional products using combinations of materials, including polymers, metals, and ceramics, illustrated through relevant case studies. He also covered the Ceramic Hybrid Additive Manufacturing Platform (CHAMP), which enables the industrial-scale production of ceramic parts for applications such as batteries and medical implants. The session further provided an opportunity to discuss potential research collaborations between SC3DP and the University of Leeds.

3D Bioprinting Day - Explore, Learn, Experience



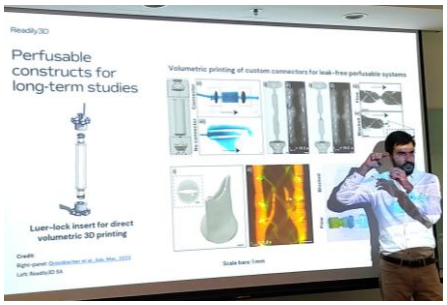
As part of the Research Innovation and Development Laboratory with CELLINK (Sweden), we organised on 14 October, a 3D Bioprinting Day. During this event, **Dr. Wei Zhu**, CELLINK's Chief Technology Officer, delivered a keynote, sharing the latest bioprinting innovations. SC3DP's researchers, **Dr Ng Wei Long** (3D Printing of Salmon Sashimi Analogues using Fish-Derived Food Inks), **Cui Yufei** (Rapid DLP Printing of Small-Scale Functional Hydrogels on BIONOVA X: A Cell-Safe, High Resolution Workflow for Micro-Scale Hydrogel Architectures), **Verena Tirtajas** (3D Bioprinting of Decellularized Extracellular Matrix for Keratoconus Treatment), and **Ni Xiyao** (Embedded 3D Printing of Piezoelectric PLLA Scaffolds) presented the latest results of projects being conducted at SC3DP using CELLINK technology. Other speakers included **Dr Yang Yuanhang** (School of Mechanical and Aerospace Engineering, NTU) and **Dr Song Yongteng** (School of Mechanical and Aerospace Engineering, NTU). The event also featured live demonstrations of various CELLINK's systems available at SC3DP.

3D Printing for Extreme Manufacturing

On 19 September, SC3DP hosted a webinar on 3D Printing for Extreme Manufacturing, co-hosted by the **International Journal of Extreme Manufacturing - the top-ranked journal in the field of manufacturing.** This session was part of our ongoing webinar series, organised once every two months to share research and developments in advanced manufacturing. The webinar highlighted how bioprinting holds the potential to transform the future of regenerative medicine and personalised healthcare. It explored the latest advances in bioprinting technology, including bioink formulation, the integration of cell-laden scaffolds, and the creation of complex tissue structures closely resembling native human anatomy.

The session also examined current applications (such as organ-on-a-chip systems, wearable bioelectronic devices, and regenerative medicine), emerging research directions (including AI-driven approaches and precision ultrasound bio-assembly), and the key challenges that must be addressed to produce fully functional, transplantable organs. Three distinguished professors shared thoughtful reflections on the progress, opportunities, and remaining obstacles within the field of biofabrication. The webinar attracted impressive engagement: *Total views: 12,256* | *Unique viewers: 10,136* | *Peak concurrent viewers: 894*

Volumetric Bioprinting - Can Shape Bring Us Closer to Function



On 30-31 October, SC3DP hosted a seminar on tomographic volumetric bioprinting titled “Can Shape Bring Us Closer to Function,” delivered by **Dr. Jorge Madrid-Wolff** from Readily3D, Switzerland. This seminar introduced Readily3D’s innovative volumetric printing approach, which enables rapid, support-free fabrication of complex biological structures through a sterile, contactless optical process. Participants also witnessed a live demonstration of the volumetric bioprinter. **SC3DP is the only research centre in Singapore with this technology**.

UPCOMING EVENTS & SEMINARS

NTU Open House 2026 - Date: 28 February. Website: https://www.ntu.edu.sg/OpenHouse

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2nd International Conference on Future of AM 2026

Visit the official conference website. https://futuream.sg

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