PRN 2022

9th~10th, May, 2022

Venue:

- Online
- Offline: Room 206, Material Science and Engineering Centre, School of Mechanical and Materials Engineering, University College Dublin, Belfield, Dublin 4, Ireland

The Polymer Replication on Nanoscale (PRN) conference series has been held previously in Denmark, Switzerland and Germany and is established as an important international forum for leading experts to exchange latest developments, research findings and future vision for polymer micro/nano manufacturing and its applications.

It is our great pleasure to invite you to the 8th International PRN Conference, organised by the UCD Centre of Micro/Nano Manufacturing Technology (MNMT-Dublin).

PRN2022 PROGRAM

9-10 May, 2022

Venue:

Online or

Room 206, UCD Material Science and Engineering Center

School of Mechanical & Materials Engineering

University College Dublin

Belfield, Dublin4

Time	***Monday 9 May 2022, PRN 2022 Conference***	Page
09:00-10:00	Individual pre-conference meetings	
10:00-10:10	**Kenneth Stanton (Head of UCD School of Mechanical and Materials Engineering, Ireland)** Welcome address	
10:00-10:20	**Nan Zhang (MNMT-UCD, Ireland)** Welcome to the Polymer Replication on Nanoscale 2022	

Session 1: Mastering and tooling (10:20-12:55)

Chair: Michael Gilchrist (UCD, Ireland)

10:20-10:55	**Nan Zhang (MNMT-UCD, Ireland)** *Manufacturing of plastic microfluidics: Translating microfluidic devices from laboratory prototyping into scale-up production*	*30*
10:55-11:30	Invited: **Gert-Willem Römer (University of Twente, Netherland)** *Laser texturing on using (ultra) short pulsed lasers: Fundamentals and applications*	*20*
11:30-12:05	Invited: **Graham Cross (TCD, Ireland)** *Advanced mould technology for injection moulding of optoelectronic parts*	*21*
12:05-12:30	**Yang Zhang (DTU, Denmark)** *Surface micro structuring injection moulding using soft tooling*	*31*
12:30-12:55	**Tianyu Guan (UCD, Ireland)** *Synthesis of two-dimensional WS_2/nickel nanocomposites via electroforming for high-performance micro/nano mould tools*	*32*
12:55-13:15	Virtual Networking, coffee break (Online, Breakout room)	
13:15-13:50	Lunch break (individually)	
13:50-14:00	Lab tour (video version)	

Session 2: Microfluidics and functional surfaces I (14:00-17:00)

Chair: Nan Zhang (UCD, Ireland)

Time	Events	Page
14:00-14:35	Invited: **Henne van Heeren (Enabling MNT, Netherland)** *Trends in the microfluidic industry 2022*	*22*
14:35-15:00	**Rafael Taborisky (DTU, Denmark)** *Engineering of wetting properties for polymer surfaces*	*33*
15:00-15:25	**Meng Li (Zurich Instruments, Switzerland)** *Fast electrical impedance spectroscopy for microfluidic single cell characterization and counting*	*34*
15:25-15:35	Coffee break	
15:35-16:00	**Damien King (FPC-DCU, Ireland)** *Injection moulded microfluidic lab on a disc platform for extracellular vesicle analysis*	*35*
16:00-16:25	**Rohit Mishra (DCU, Ireland)** *POC Microfluidic Platform Technologies: Bridging the Translational gap*	*36*
16:25-17:00	Invited: **Jed Harrison (FPC-DCU, Ireland)** *Micron and Nano-scale Polymer Systems for Biochemical Analysis*	*23*
17:00-17:20	Virtual Networking, coffee break (Online, Breakout room)	

Tuesday 10 May 2022, PRN 2022 Conference

Session 3: Micro/nano Replication (09:00-11:00)

Chair: Damien King (DCU, Ireland)

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09:00-09:35	Invited: **Per Magnus Kristiansen (FHNW, Switzerland)** *Polymer surface topographies go industrial*	*24*
09:35-10:10	Invited: **Giovanni Lucchetta (Unipd, Italy)** *Modeling the replication of submicron-structured surfaces by micro injection moulding*	*25*
10:10-10:35	**Nastasia Okulova (In-mold, Denmark)** Roll-to-roll Extrusion Coating – expanding the boundaries of roll-to-roll replication in thermoplastic materials	*37*
10:35-11:00	**Sana Zaki (UCD, Ireland)** Shaping of mould tools manufactured by UV LIGA and 3D printing	*38*
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Session 4: Microfluidics and functional surfaces II (11:20-12:55)

Chair: Per Magnus Kristiansen (INKA FHNW, Switzerland)

Time	Events	Page
11:20-11:55	Invited: **Ruth Schmid (SINTEF, Norway)** *Nanomedicine today and tomorrow*	*26*
11:55-12:30	Invited: **Eoin O'Cearbhaill (UCD, Ireland)** *3D printing of medical devices designed towards optimal soft tissue interaction*	*27*
12:30-12:55	**Yuyang Zhou (Soochow University, China)** *Scalable mass manufacturing process for micro/nanostructure engineered plastic films with viral and microbial resistance*	*39*
12:55-13:15	Virtual Networking, coffee break (Online, Breakout room)	
13:15-14:00	Lunch break (individually)	

Session 5: Advanced materials for micro/nano structuring (14:00-16:20)

Chair: Hengji Cong (UCD, Ireland)

Time	Events	Page
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14:35-15:00	**Brian Vohnsen (UCD, Ireland)** *From wavefront sensors to retinal implants with polymers*	*40*
15:00-15:25	**S. Bishnoi (DTU, Denmark)** *Fabrication and evaluation of microgel shapes as carriers for delivery of biomacromolecules*	*41*
15:25-15:50	**Xiaoyu Wang (UCD, Ireland)** *A novel hydrophilic and antibacterial coating based on functionalized chitosan*	*42*
15:50-16:15	**Seyed Masih Mousavizadeh (UCD, Ireland)** *Multifunctional strong-bonded 3-layered polymer coating on WE43 for drug-eluting stent applications*	*43*
16:15-16:20	Voting for the Best Presentation Awards for Early-Stage Researchers (Online)	
16:20-16:40	Virtual Networking, coffee break (Online, Breakout room)	
16:40-16:50	Announcement of Best Presentation Awards and closing by Nan Zhang	
16:50-17:30	Networking, Beer/Refreshments	

Close of PRN 2022 and announcement of PRN 2023

Scope of the Conference:

The conference will address issues in large scale replication of micro- and nanostructures in polymer materials including:

- Manufacturing of structured moulds, inserts or shims for polymer replication
- Industrial replication technologies, injection moulding, roll-to-roll techniques and other innovative processes
- Materials for replication of polymer micro- and nanostructures
- Applications for functional micro- and nanostructured polymer surfaces
- Metrology and characterisation of micro- and nanostructured polymer surfaces
- Simulation and computing of different phenomena for micro- and nanoscale replication

Local Organising Committee:

- Nan Zhang (UCD, Ireland)
- Michael Gilchrist (UCD, Ireland)
- Graham Cross (TCD, Ireland)
- Damien King (FPC-DCU, Ireland)
- Hengji Cong (UCD, Ireland)

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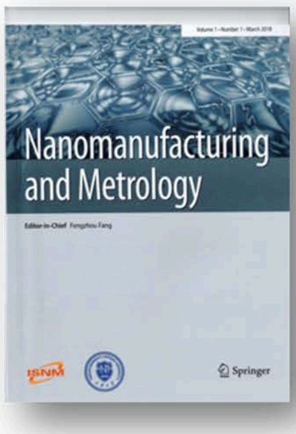

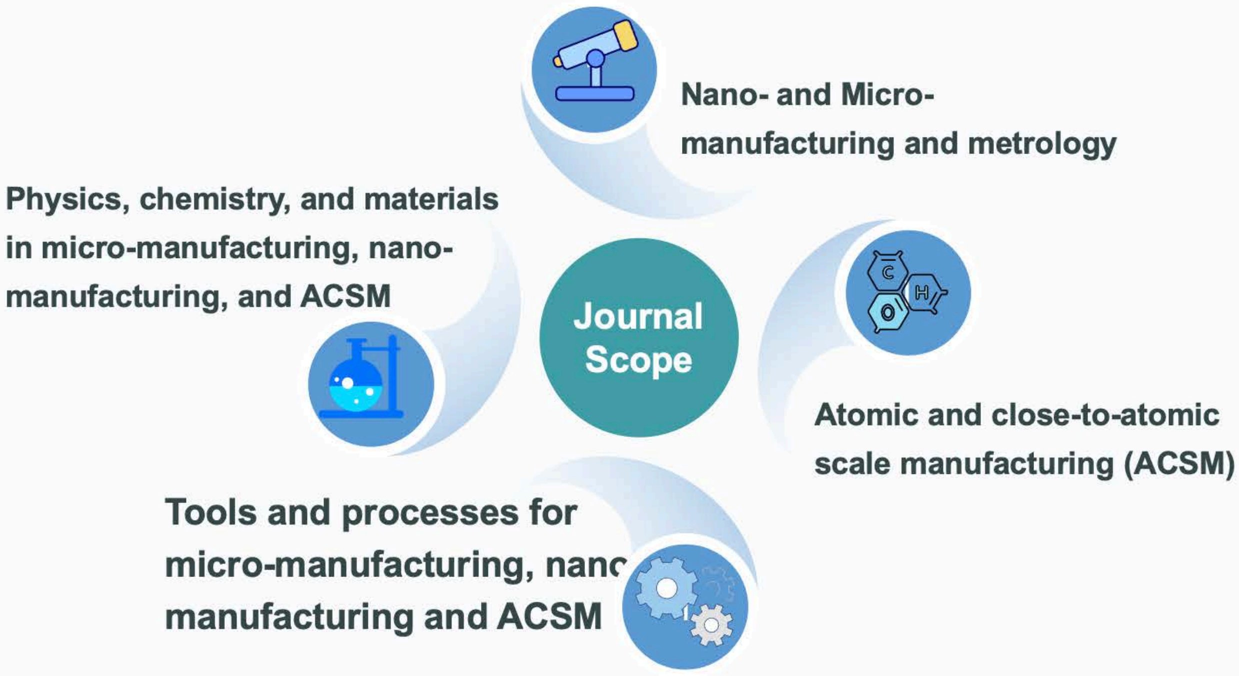

Journal Metrics

- Indexed in **EI Compendex**, Scopus, Inspec, CAS, etc.
- Citescore 2020: **4.4** Citescore Tracker 2021: **6.2**
- Project for Enhancing Impact of China STM Journals **Category D**
- 2021 The Highest International Impact Academic Journal of China, with the International Influence factor **3.688**

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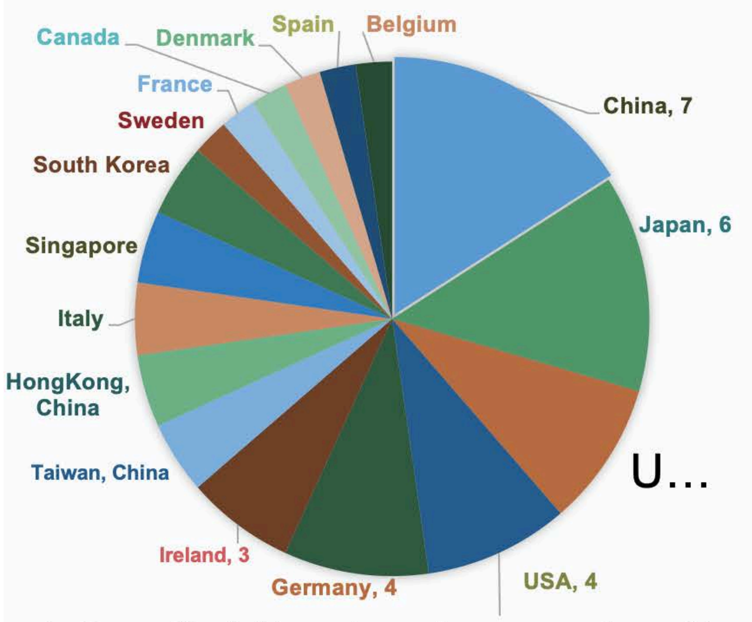

- Our editorial board members come from 17 countries and regions, with 84% from abroad.
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Special issue:

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Advanced Manufacturing of Micro- and Nanotextured Polymer Surfaces

Guest Editors:

Dr. Nan Zhang
School of Mechanical and Materials Engineering, University College Dublin, Dublin, Ireland

nan.zhang@ucd.ie

Prof. Dr. Per Magnus Kristiansen
Institute of Polymer Nanotechnology, FHNW University of Applied Sciences and Arts Northwestern Switzerland, Windisch, Switzerland

magnus.kristiansen@fhnw.ch

Deadline for manuscript submissions:
31 July 2022

Message from the Guest Editors

Dear Colleagues,

The global trend towards miniaturization has been expanding into many areas of human life, enabled by the realization of ever-smaller mechanical, optical, medical, and electronic products. Due to comparably low cost and industrial up-scalability, polymer materials are favorable for the production of surface micro- and nanoscale surface topographies for integrated systems, such as microfluidic devices, micro-optics, and functional surfaces. Polymer micro/nano manufacturing technologies are broadly composed of molding and forming processes as well as additive and subtractive manufacturing processes.

This Special Issue is dedicated to recent advances in research and development within the field of advanced manufacturing of micro- and nanotextured polymer surfaces. We are looking for papers that report recent findings and developments in manufacturing technologies and applications for polymeric micro- and nanoscale surface topographies.

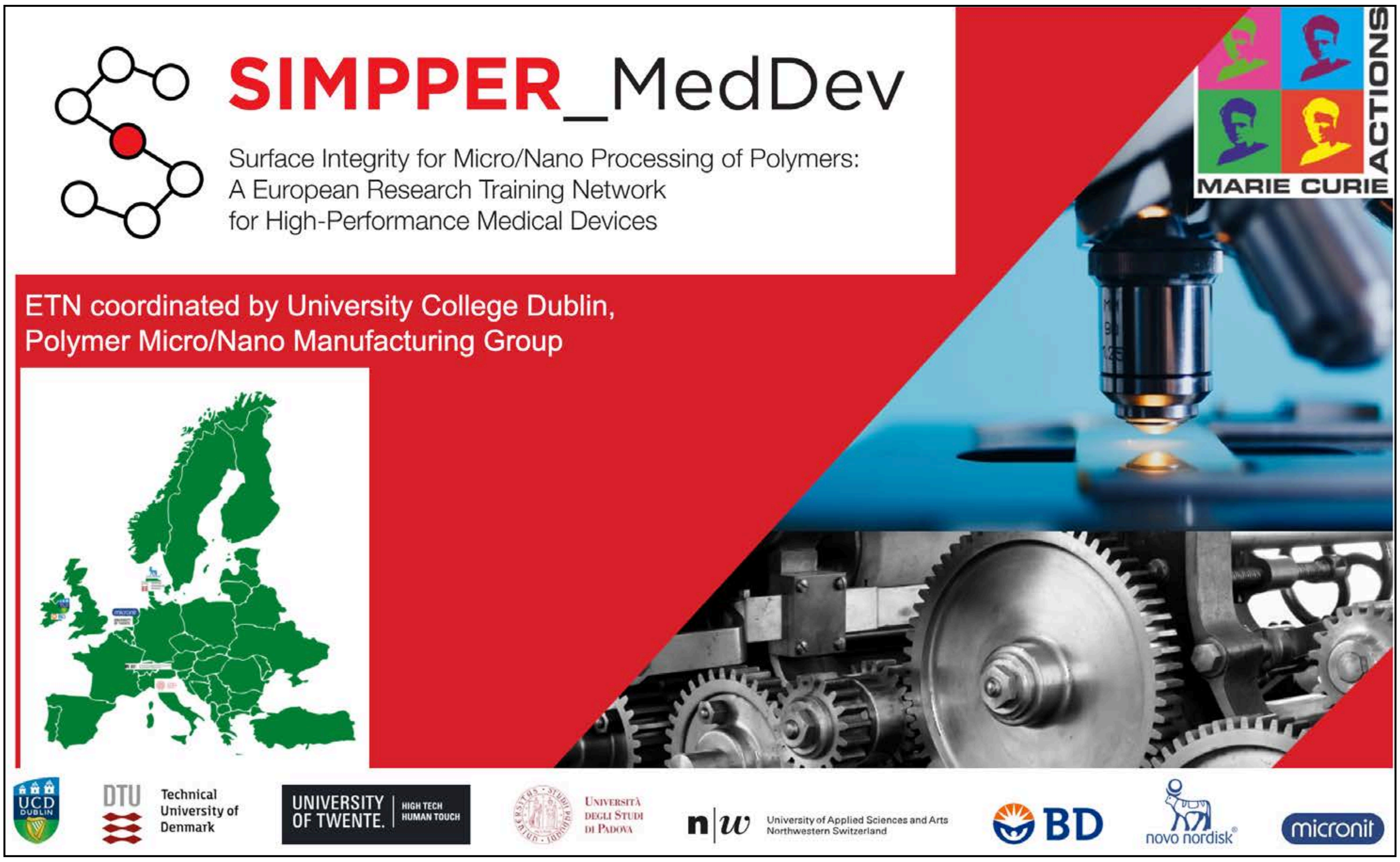
Dr. Nan Zhang
Prof. Dr. Per Magnus Kristiansen
Guest Editors

mdpi.com/si/86333

Special Issue

Best presentation award to early-stage researchers:

Supported by H2020-MSCA-ITN: SIMMPER_MedDev



Nickel mould with minimum channel size 80micron, aspect ratio ~3
@Produced by MNMT-Dublin

Microinjection moulded plastic Microfluidic chip
@Produced by MNMT-Dublin

WELCOME

Dr Nan Zhang

Welcome to the PRN 2022

On behalf of the organising committee, I sincerely welcome you to University College Dublin for the 8th International PRN Conference.

It is my pleasure to host PRN 2022 at UCD by gathering world leading experts in the area of ultra-precision/precision machining, micro/nano replication and applications that pertain to microfluidics, optics and medical devices. Ireland is one of Europe's largest MedTech hotspots and, as a globally recognised centre of excellence, is home to 300+ companies, employing 32,000 people. Nine of the world's top ten medical device companies have manufacturing operations here. As polymer materials are important for medical device manufacturing, there are more than 230 polymer companies in Ireland with employing 7,000 people and with exports valued at €1.62 billion annually. However, most of these companies focus on large-scale product manufacturing. Polymer micro/nano manufacturing has been used in many fields including medical technology, automotive technology, life science and optical industry. Future developments will include developing freeform large-area micro/nano structures for innovative applications. It is our wish that this conference will trigger innovation and encourage new connections between our participants.

PRN 2022 has an exciting programme in which you will hear about state-of-the-art technologies in fabricating Micro/Nano masters and mould tools, micro/nano replication using nano imprinting and injection moulding, and advanced materials for micro/nano structuring, and applications in areas of microfluidics, optics and biomedical devices. The coming two days will present a strong programme of 9 invited talks and 14 oral presentations.

We wish that you enjoy the conference and find it fruitful for your network and development.

Thank you and enjoy!
Nan Zhang

INVITED SPEAKERS

Jed Harrison
Professor, Department of Chemistry, University of Alberta, Edmonton, AB, Canada
Professor, Dublin City University, Dublin, Republic of Ireland

"Micron and Nano-scale Polymer Systems for Biochemical Analysis "

Biography:
Prof. Jed Harrison (Scientific Director of FPC@DCU) is co-author of +250 scientific publications, including reviews, books and patents (Scopus h-index 60, 14456 citations). His research is focused on the application of microfabrication methods and micromachining technologies to analytical systems and chemical sensors. He is the recipient of a number of awards (e.g. Canadian Society for Chemistry's McBryde Medal, Maxxam Award, the Golay Award, elected Fellow of the Royal Society of Canada). He has supervised numerous postdoctoral researchers, PhD, MSc and BSc students.
He has a strong record in the delivery of impactful research have contributed to more than 400 research publications in the field of microsystems and microfluidic lab-on-a-chip technologies, amongst them over 100 scientific papers in mostly top-quartile journals (78 senior authored). His latest h-index at Scopus amounts to 60 (as of January 2022). His application-focused, translational research approach is documented by an intellectual property portfolio comprising of 25 granted patents, about 60 filings, and an extended track record of successful collaborative research and technology development projects with industrial and leading-edge academic partners. His work has spawned several successful commercialisation activities, patent licencing and the foundation of companies and he has served on Scientific Advisory Boards of several technology start-ups and multinational companies. He has contributed to raise research income of more than €59 million, of which more than €15 million has directly supported my own group's/centre's research and technology development activities.

INVITED SPEAKERS

Dr. Ruth Schmid
Vice President Marketing at SINTEF Industry in Trondheim, Norway

"Nanomedicine today and tomorrow"

Biography:
Dr. Ruth Schmid is Vice President Marketing at SINTEF Industry in Trondheim, Norway with special responsibility for the area of medical technology, including nanomedicine. SINTEF is one of Europe's largest independent non-profit research institutes. She has an undergraduate education in organic chemistry and a PhD in physical organic chemistry from ETH Zürich, Switzerland. Her present research activities include the preparation and characterisation of micro- and nanoparticles by various technologies and from a wide variety of materials (including biodegradable polymers and hybrid materials), as well as the surface modification of polymers and polymer particles by wet chemistry, to introduce tailor-made properties. Lately, focus has been on the encapsulation and immobilisation of liquids and solids from emulsions, for protection and controlled release. Another focus has been on coating of biomaterials by self-assembling methods and covalent attachment with biocompatible, biomimetic and functional coatings, e.g. for introduction of antimicrobial properties, for increased osseo-integration or for immobilisation of biological molecules. A field of special interest are the emerging fields of nanomedicine, targeted drug delivery and release, nanotechnology-based diagnostics and regenerative medicine, with special focus on applications based on particle technology and surface modification. She has special focus on applied research and product orientated solutions and has long-term experience in translation from lab to pilot scale, e.g. through the development of the Dynabeads. She has business development experience, e.g. through SINTEFs various drug delivery platforms. She is a past president of the Controlled Release Society (CRS) and the past chair of the European Technology Platform on Nanomedicine (ETPN). She is a member of the College of Fellows of AIMBE and CRS. She is author/co-author of 67 peer reviewed publications (citations 2358; h-index. 22).

INVITED SPEAKERS

Prof. Wenxin Wang
Science Foundation Ireland Principal Investigator

"Biopolymer-based tough hydrogel for additive manufacturing"

Biography:
Wenxin Wang is Full Professor in Skin Research and Wound Healing, a Science Foundation Ireland (SFI) Principal Investigator at the Charles Institute of Dermatology, School of Medicine, University College Dublin (UCD), and a member of UCD Academic Council. He won the highly prestigious "Young Scientist Prize in Regenerative Medicine" in 2010 at TERMIS-EU conference, the "SFI Principal Investigator award" in 2011 and the DEBRA Award for Excellent EB Patient Service in 2014, which highlight his work ethic and achievements. Prof. Wang's scientific interests are in the areas of biomaterials, stem cell and gene therapy for the treatments of skin wounds, cardiovascular and neural degenerative diseases. His scientific contribution and achievements have been recognized both nationally and internationally including over 200 peer-reviewed scientific journal papers (Nat. Commun., Nat. Rev. Chem., Sci. Adv., Angew. Chem., JACS, Chem. Sci. and Nano Letters etc.), 5 book chapters, 25 patents, 140 conference abstracts and presentations, and 110 invited lectures and keynote presentations. Since 2009 he has graduated 19 PhD students and mentored over 25 postdoctoral researchers. His achievements have gained the increased interest in the wider public community with publicity media activities (56 times in TV Documentary, Videos and Newspapers), for example in RTE-TV, 'The Sunday Times', 'The Irish Times', 'Science Daily' and 'Chemistry World'. He has been awarded significant funding (ca. 11.3 million Euros) from different sources, e.g., SFI, Health Research Board (HRB), Irish Research Council (IRC), Enterprise Ireland (EI) and European Union (EU-FP7 & EU Horizon 2020) to support his research activities. Prof. Wang has acted as the symposium convener and chair, the member of organizing committees and the member of the conference advisory board for 31 international conferences and has been selected as an expert reviewer and panel member by 25 international research councils and funding bodies. As the founder, Prof Wang has launched 3 companies - Vornia Ltd (www.vornia.com, acquired by Ashland - a Fortune500 US company in Jan. 2018, renamed as Ashland Specialties Ireland), Blafar Ltd. (www.blafar.com), and Branca Bunús Ltd. (www.brancabunus.com). Furthermore, he has licensed 7 new technologies to 4 companies: Ashland, Amryt Biopharm, Blafar and Branca Bunús, and successfully launched and commercialized 5 newly developed technologies onto the market.

INVITED SPEAKERS

Henne van Heeren
Funders of enablingMNT and one of funding members of the Microfluidics Association

"Trends in the microfluidic industry 2022"

Biography:
Henne worked as a production manager and business development manager in the industry. In 2003 he was one of the founders of enablingMNT. Currently Henne is working within enablingMNT as a consultant and market analyst in the field of microfluidics. One of his activities is assisting (start-up) organizations in the process of industrialization and commercialization. Recently he brought together several parties interested in the development of guidelines and standards for microfluidics. He is one of the founding members of the Microfluidics Association, where several companies and other organisations are working together developing industry wide applicable protocols and standards in microfluidics.

PROF.DR.IR. G.R.B.E. RÖMER (GERT-WILLEM)
Chair of Laser Processing, University of Twente, The Netherlands

"Laser texturing using (ultra) short pulsed lasers: Fundamentals and applications "

Biography:
Prof.dr.ir. Gert-willem Römer holds a PhD in Mechanical Engineering (1999) of the University of Twente in The Netherlands. He has over 20 years of experience in executing as well as managing national and international research projects in the field of laser-material processing, for a large number of public bodies and companies. He is currently (co)leading 5 research projects, involving 8 PhD's. He is co-author of over 60 publications in peer-review scientific journals, 4 books, 5 book chapters, 6 patents and over 80 conference contributions. His scientific focus is on the fundamental physical phenomena occurring during laser-material interaction, in order to optimize laser-material processing for laser-based manufacturing. Main processes are material processing using ultra short pulsed laser sources for micro- and nano-machining, and laser cladding and additive manufacturing (3D printing) using high power laser sources. As well as, the development of models, as well as sensors and real-time control algorithms for laser-material processes (to ensure reliable processing results). In addition, as manager R&D of a company (2002-2008), he developed advanced robotics medical aids, and developed a broad experience in knowledge transfer and management of R&D projects in the private sector.

INVITED SPEAKERS

Prof. Dr. Per Magnus Kristiansen
FHNW University of Applied Sciences and Arts, Northwestern Switzerland, School of Engineering, Institute of Polymer Nanotechnology (INKA), Switzerland

"Polymer surface topographies go industrial "

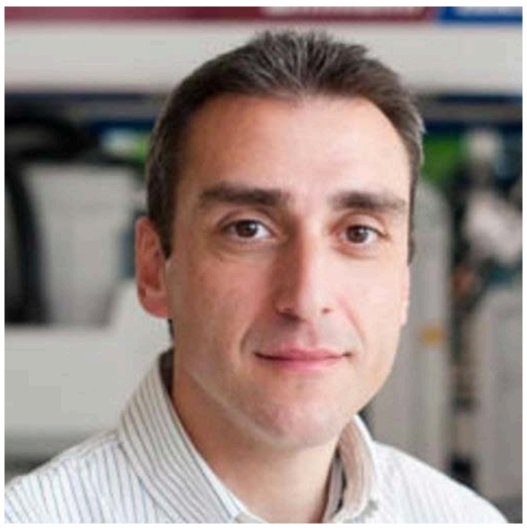
Biography:
Prof. Dr. Per Magnus Kristiansen is head of the INKA Institute of Polymer Nanotechnology at FHNW University of Applied Sciences and Arts Northwestern Switzerland. He studied Materials Sciences and did his PhD in Polymer Technology both at ETH Zürich. From 2004 to 2009, he gained industrial experience at Ciba Specialty Chemicals, first in R&D on supramolecular additives for nucleation/clarification, breathable films, and electret filters and later focusing on stabilizers and functional additives as application specialist for the automotive industry. Since 2009, he is Professor in Polymer Nanotechnology at FHNW and since 2016 head of the institute INKA. In 2020, he was appointed Visiting Full Professor at the University College Dublin in connection with the H2020 MCS-ITN project SIMPPER_MedDev. Furthermore, he is co-founder of the start-up Bott Neuro AG and advisory board member of several Swiss SMEs.
His primarily applied research focuses on the functionalization of polymers by surface structuring on the micro- and nanoscale with particular emphasis on industrial replication technologies for microfluidic diagnostics, life science and optics applications as well as other types of functional polymer surfaces. Further research topics at INKA include laser ablation of polymeric materials and functional coatings by means of irradiation curing (UV, Ebeam) and atmospheric plasma processes, as well polymer processing, phase behavior and structure-property relationships.

Graham L. W. Cross
Associate Professor Physics and PI in the AMBER/CRANN, Nanomaterials Institute at Trinity College Dublin

"Advanced mould technology for injection moulding of optoelectronic parts"

Biography:
Graham Cross, FTCD is Associate Professor Physics and PI in the AMBER/CRANN Nanomaterials Institute at Trinity College Dublin. After his Ph.D. on atomic scale indentation at McGill U. (Montréal, Canada), Prof. Cross worked on atomic-force microscopy (AFM) based data storage for IBM Research in Zürich, Switzerland as an FCAR Fellow. At Trinity College his research highlights include fundamental studies of size effects in polymer melt processing flows and discovery of macro-scale self-assembly and superlubricity in graphene. He has commercialized diamond nanoelectromechanical systems (NEMS), spinning out a profitable start-up company (Adama Innovations Ltd). Prof. Cross leads research collaborations in superlubricity (EIC SSLiP project) and 2D material self-assembly (SFI Pleatronics project) as well as participating in nanoscale moulding (EU FLOIM), nanowire metrology (EuroMet NanoWires) and 2D material composites (SFI AMBER II) projects.

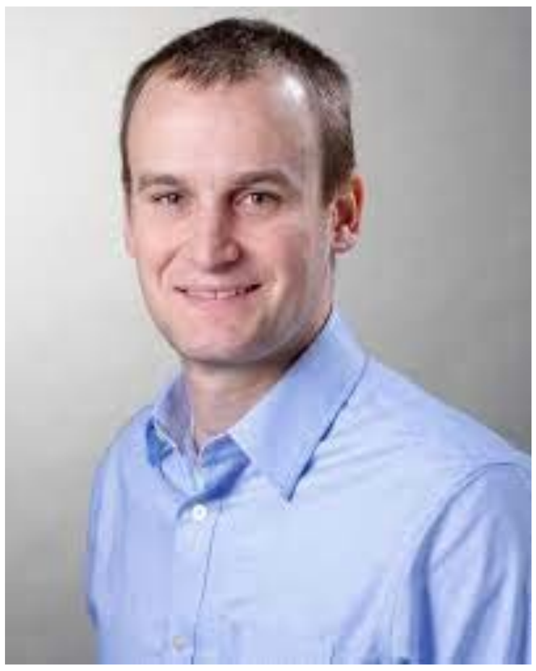
INVITED SPEAKERS



Giovanni Lucchetta
Associate Professor, University of Padua

"Modeling the replication of submicron-structured surfaces by micro injection moulding "

Biography:
Dr. Giovanni Lucchetta is Associate Professor in Manufacturing Engineering at the University of Padova. His research is focused on forming technologies of polymeric materials and on microtechnologies, with particular reference to injection molding. The main research topics are: i) Replication of microstructured and nanostructured surfaces for microfluidic and biomedical applications with particular reference to the analysis and modeling of replication and ejection of high aspect ratio features. ii) Injection molding of polymer compounds, with particular reference to the analysis and modeling of the orientation and concentration of filler particles, to the development of technologies for the rapid variation of the mold temperature and to the study of their effects on surface properties of the molded parts. iii) Modeling and characterization of the tribological effects of the mold surface properties in the injection micro-molding process with the aim of producing complex 3D parts and improving both the filling flow of the polymer melt in narrow cavities and the ejection of the molded micro parts.
Dr. Lucchetta has participated in several national and international research projects evaluated by peer-review. As an Associate Member of the International Academy for Production Engineering (CIRP), he has an active role in Scientific Technical Committees on Surfaces and Forming. He has been a member of the Polymer Processing Society (PPS) community since 2010 and president of the Italian Division of the Society of Plastics Engineers (SPE).
Dr. Lucchetta is author of 112 publications in international journals or proceedings of indexed international conferences. The majority of these are related to injection molding and published in peer-reviewed journals (H-index: 22. Total citations: 1377).



Eoin O'Cearbhaill
Associate Professor in Biomedical Engineering, University College Dublin

"3D printing of medical devices designed towards optimal soft tissue interaction"

Biography:
Dr. Eoin O'Cearbhaill, BE, PhD, is an Associate Professor in Biomedical Engineering at the UCD School of Mechanical & Materials Engineering. Prior to joining UCD, Dr. O'Cearbhaill was a Postdoctoral Fellow at Harvard Medical School (Harvard-MIT Health Sciences & Technology Division; Dept. of Medicine, Brigham & Women's Hospital), where his research focused on the conception and development of medical devices and the delivery of next generation therapeutics, in the laboratory of Prof. Jeffrey Karp. Based on his development of a mechanical clutch needle, designed to prevent through-puncture injuries, Dr O'Cearbhaill was awarded 1st prize at the MIT Sloan BioInnovations 2012 conference. He was also part of the team that received the Institution of Chemical Engineers' Innovative Product of the Year Award 2013 for their work on developing a bio-inspired microneedle adhesive. Dr O'Cearbhaill obtained his BE (Biomedical) and PhD from NUI Galway. His doctorate focused on applying mechanical stimulation to MSCs for vascular tissue engineering applications. Subsequently, he worked for Veryan Medical, before joining Creganna-Tactx, where he worked in both manufacturing and design service roles, helping to establish their Specialty Needles Division in Marlborough, MA.

INVITED SPEAKERS

Nan Zhang
Lecturer/Assistant Professor, School of Mechanical and Materials Engineering,
University College Dublin

"Manufacturing of plastic microfluidics: Translating microfluidic devices from laboratory prototyping into scale-up production"

Biography:
Dr Nan Zhang is an Assistant Professor in Manufacturing and Design in the School of Mechanical and Materials Engineering at University College Dublin (UCD) in Ireland. His research work covers the polymer micro/nano manufacturing, precision manufacturing of plastic microfluidic chips, manufacturing functional micro/nano structured surfaces and miniature medical devices, microfluidic systems for the synthesis of genetic nanomedicine and molecular diagnostics, and atomic and close to atomic-scale manufacturing. Dr Zhang has won 4.5Million grant in his early career, including a recent funded H2020 MSCA ITN Grant as a consortium coordinator. He have published more than 35 peer-reviewed journal papers, in Materials Today, Nano letters and International Journal of Machine Tool and Manufacture. His work was also funded by Science Foundation Ireland, Enterprise Ireland-Commercialization Funding, Irish Research Council and University College Dublin etc. He was the chair of the 6th international conference on polymer replication on the nanoscale (PRN2019,PRN2022). His research has generated several patents which have been commercialised or are in the process of being commercialised.

ABSTRACTS FOR INVITED PRESENTATIONS

Laser texturing on the using (ultra) short pulsed lasers; fundamentals and applications

G.R.B.E. Römer

[1] University of Twente, Chair of Laser Processing, Enschede, The Netherlands

The interaction of every device, component or part with its environment depends mainly on its surface-properties and to a much lesser extend to its bulk properties. More specifically the interaction depends on the morphology of the surface texture (roughness), as well on the chemical composition of the surface. By applying a surface texture, with feature sizes on the micro- and nanometer scale, the surface-can be optimized and adapted for specific applications in the field of the tribology, optics, fluidics (wetting), electronics, and other fields.

When compared to other surface processing techniques, laser surface texturing, using (ultra) short pulsed laser sources (with pulse durations ranging from femtoseconds to nanoseconds), allows efficient, flexible and clean machining of a surface by removing (laser ablation) or modifying the surface of the material on the micro- and nanometer scale.

This talk will focus first on the physical phenomena occurring during of laser-material interaction during two laser-induced surface processing techniques. The first technique focusses on laser ablation for surface texturing on the micrometer scale, see Figure 1(a). When the laser pulse is sufficiently short it will directly break the chemical bonds in the material. That is, by proper selection of the laser parameters, the material is not melted, nor vaporized, but removed as highly ionized plasma, which is referred to as cold ablation. Unlike processing using relatively long pulse duration of about ns and longer, where repeatability is hindered by the randomness of the melting process, ultrashort laser pulses result in accurate machining. The second technique, which will be addressed, creates Laser-induced Periodic Surface Structures (LIPSS) on the surface of a substrate. LIPSS are highly regular surface textures with periodicity and amplitude on the nanometer scale, see Figure 1(b)-(d). LIPSS can be formed on nearly any type of material The periodicity and amplitudes of LIPSS (ranging from a few tenths of nm to 1 µm), as well as the orientation of LIPSS can be well controlled by the laser wavelength, pulse energy, angle of incidence of the laser beam, number of pulses and polarization.

Next, strategies, methods and tools to scale the technology to industrial production rates are discussed.Finally, some applications of laser surface textured surfaces, including biomimetic engineered surfaces, are presented.

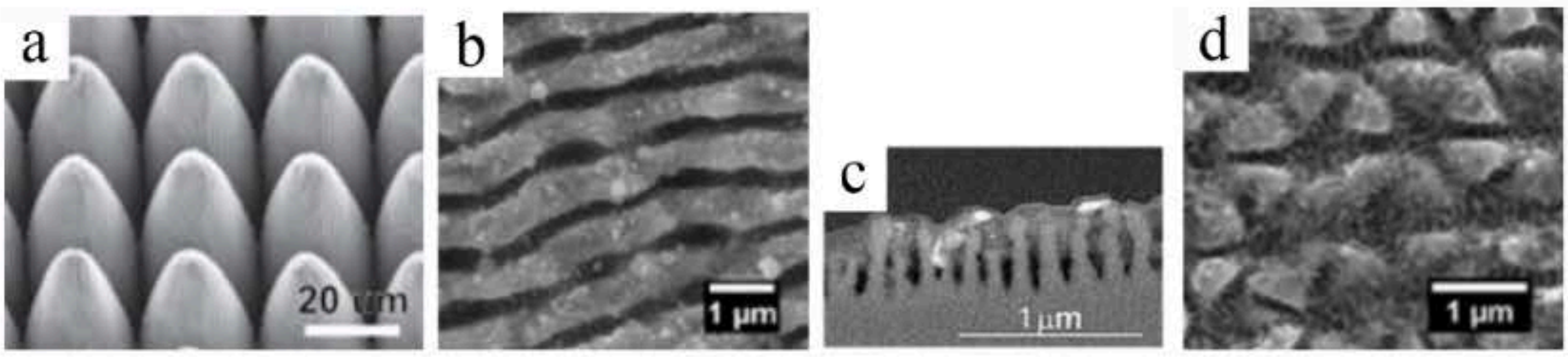


Figure 1: (a)-(d) & (f) SEM micrographs of micrometer and nanometer sized laser textured surfaces. (a) Isometric view of µm sized array of pillars created by cold ablation, covered by Laser-induced Periodic Surface Structures (LIPSS) [1]; (b) Top view of Low spatial frequency LIPSS (LSFL) [2]; (c) Cross section of High Spatial Frequency LIPSS (HSFL) [3]; (d) Top view of laser-induced Triangular Nano pillars (TNPs) [2].

References

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New nanometric technologies for diamond-like-carbon (DLC) injection mould inserts

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Miniaturized, integrated photonic devices are driving an increasing number of applications, while facing pressure to lower cost and increase flexibility. In this talk I discuss the development of diamond like carbon (DLC) injection mould inserts for optoelectronic packaging applications, and a novel mould filling sensor with nanometric sensitivity.

A large area, high-resolution grating with micrometer scale features and nanometric finish for an optical encoder has been produced using ion implant masking[1, 2] and tested for compression injection mould replication and optical performance. I review the fabrication and characterization of the mould.

In addition, a new sensor developed at TCD based on fibre-optic interferometry is introduced. We show time-resolved sensing with 10's nm position sensitivity of microcavity injection mould filling by polymers with nanometre displacement resolution. The interferometer was capable of resolving melt front motion into the microcavity to the point of complete filling as verified by atomic force microscopy. A ~60 nm vertical resolution was determined despite the low reflectivity of the transparent polymer and unoptimized reflected light collection optics. The simplicity and flexibility of the technology may allow straightforward instrumentation of injection mould, embossing and nanoimprint tooling to monitor local, nanometer scale filling processes.

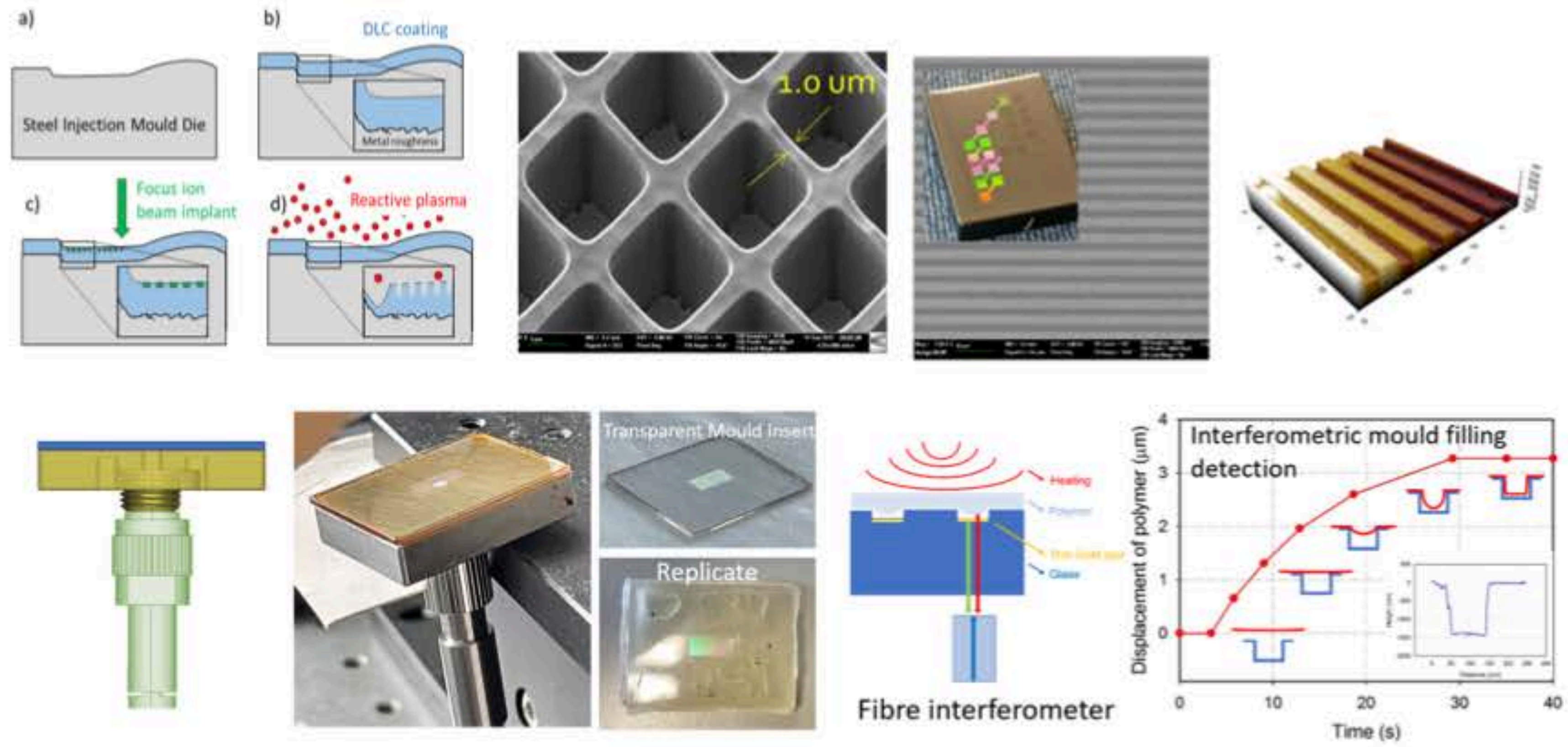

Figure 1: Principle of ion implant masking to pattern DLC film coated steel injection mould inserts (a)-(d) and produce high resolution, high relief, large area patterns (top row.) Representative illustration with a sufficiently explanatory figure caption. Lower row: New fibre-optic sensing element mounted to injection mould insert (lower row) with high performance filling measurement of capped transparent mould demonstrated (lower left).

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Trends in the microfluidic industry 2022

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Microfluidics is diverse; there are many applications and many different technologies used. The industrial community is also diverse, we have a supply chain of specialist component suppliers, specialist fabrication service suppliers and manufacturers who added microfluidics to their capabilities. This supply chain is feeding companies offering lab instrumentation, R&D tools, medical diagnostic devices and other products. Most of the microfluidics start ups of the last 25 years have survived or have been acquired by large established companies. In that sense this is a very successful industry. The other side of the picture is that the road to success is long, and many survivors have not (yet) been able to grow. The last two years we have seen an increased interest in microfluidics from governments, investors and established industries. This was driven by the urgent need for fast and accurate diagnostic instruments for COVID testing. Besides that, there are many other applications of microfluidics that are flourishing, for instance 3D (bio)printing and Organ on chips. Several smaller players saw new opportunities for growth. How sustainably these new opportunities are remains to be seen. Beside these exiting developments there is growing awareness that the diversity mentioned above with its many opportunities has a darker side: lack of quality of production technologies, long time to market and difficulty to combine components from different suppliers.

The need for standardization of microfluidic connectors was long ago stated and different way forwards have been proposed. [1 2] Although the microfluidic community did not doubt the need for standards and shared guidelines, there was no agreement on the way forward. After four years working together informally, two years ago the Microfluidics Association (www.microfluidics-association.org, MFA) was founded to bring the microfluidics community together to work on microfluidic standards and guidelines. MFA founders have initiated the standardization working group ISO/TC48/WG3, set up to address standardization of microfluidic components, interfaces, protocols for associated testing and protocols for microflow control to be applied in the development and the fabrication processes (manufacturing, testing and assembly) of microfluidic devices. Recently the group published its first standard: *Microfluidic devices — Interoperability requirements for dimensions, connections and initial device classification*

Interviewing the microfluidics experts from the supply chain, showed that besides microfluidic connectors, testing was also an issue. In more mature industries one can rely on well studied testing methods and technologies, which makes high yield production of reliable components and devices possible. Unfortunately, metrology for microfluidics fabrication has been neglected up till now. [1] This was recognized by some metrology institutes. Supported by MFA members and based on the priorities defined by the MFA they initiated a project to develop test protocols for microfluidics that will facilitate communication for mutual understanding between customer and supplier and normalize testing practices between companies: MFMET (www.mfmet.eu). More specifically test protocols for:

- dimensions of microfluidics structures and characterization of the interface between material and medium to be able to predict the flow resistivity / pressure decay inside the device,
- quality of the bonding,
- optical transmission of the used materials,
- microfluidic leakage, burst pressure and maximal operating temperature,
- fast changing flow rates, and
- measurement of fast changing flow rates.

Protocols deriving from such systems would not only be important for the user but also map process (in)stabilities for the manufacturer. This is essential for further quality improvement and yield increase. Success is only guaranteed when the community, industrial and academic contribute to this.

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Micron and Nano-scale Polymer Systems for Biochemical Analysis

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The Fraunhofer Project Centre's (FPC) development of injection molding methods for fabrication of microfluidic systems is a touchstone of this presentation. Centrifugal fluidic devices for the assay of biosystems will be described, along with the challenges associated with switching from milling to injection molding methods. The fabrication of polymer monoliths to create porous media for separations, sample concentration, and bioanalysis will be examined in detail. Recent efforts in developing 3d-metal printing methods to create similar microporous media within microfluidic systems may be discussed briefly.

Low cost fabrication of single use, disposable microfluidic devices for biochemical assays is a critical requirement for economic success of the microfluidics technology. FPC has worked extensively with IPT of the Fraunhofer Centre in Aachen to develop injection molding methods for centrifugal disk fabrication. The ability to reproduce specific shapes, sizes and structures reproducibly is critical to proper performance of the fluidic elements. Figure 1 shows images of an injected molded device for the performance of immunoassays and biomarker recognition designed as a septic assay device. Critical concerns in this process will be discussed.

The fabrication of nanoporous structures within microfluidic devices is also critical to device performance, especially the ability to fabricate repeatable, constant fluidic-resistance elements for sample concentration, separation and analysis. Photopolymerizable polymer monoliths are an excellent candidate for fabrication of nanoporous structures within microfluidic devices. Careful control of composition and fabrication parameters is required to achieve reproducibility, and with that in hand multiplexed bioassays can be achieved, allowing for complex multi-step processes. Figure 2-4 illustrate nanoporous columns, multiplexed sample fraction on such columns, and resultant mass spectrometry of individual protein fractions after digestion, as delivered from a microfluidic chip..

Polymer materials and control of their properties will play a critically important role in the financial viability of microfluidic systems for clinical bioassays.

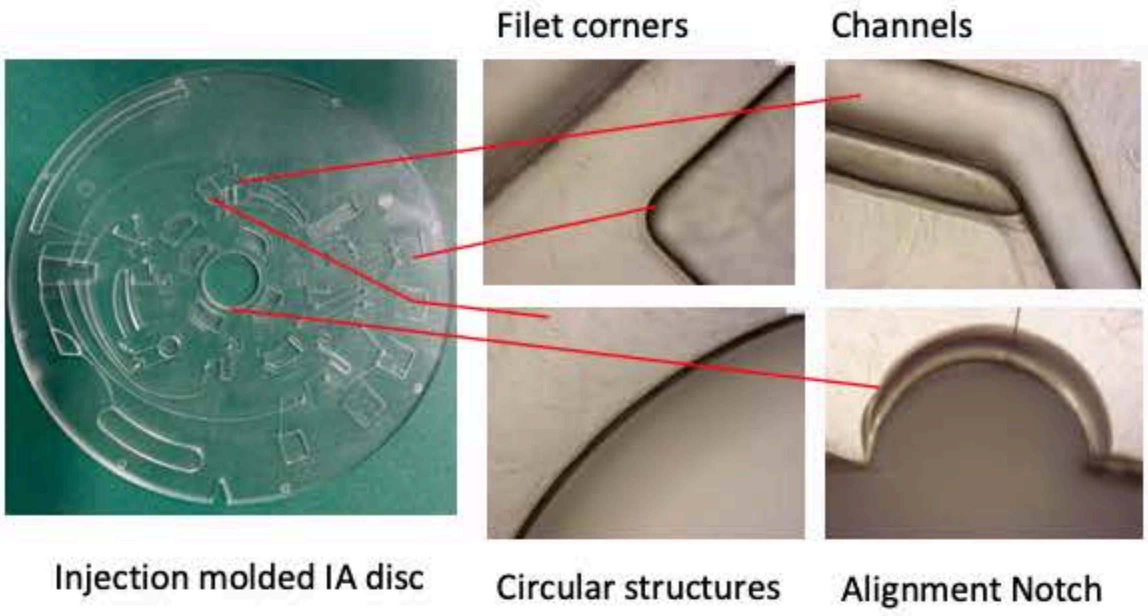

Figure 1: Image of injection molded fluidic disk for immunoassay. [Arial 10pt]

Figure 2: (left to right) SEM of polymer monolith embedded in device for fractionation, sample concentration, enzyme digestion; image of sample fractionation; mass spectrumof Bovine serum albumin digest from microfluidic chip.

Polymer surface topographies go industrial

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Functional surface topographies are receiving increasing attention for adding value to polymer products by providing them with special surface properties. These range from modified wetting behavior, altered frictional and/or haptic properties, to designed optical functions, decorative, anti-counterfeit or even holographic elements.

Polymer replication on the micro- and nanoscale has tremendously matured over the last decades on an industrial level with great achievements in injection (compression) molding, nanoimprint lithography as well as different roll-to-roll processes. Nonetheless, many challenges remain along the entire value chain as well as within the product development phase to bring surface textured polymer products to the market.

In this talk, I will present a few examples of successful industrialization projects, in which we have been involved over the years. Emphasis will be put on discussion of the challenges involved and the hurdles taken in order to transfer lab-scale processes into an industrial setting as well as pronounced differences in the required timelines, ranging from less than a year to almost ten years. Examples include among others the development of a novel violin support [1], a multiplex blood diagnostics platform [2] and polymer supports for protein crystallography [3-4].

The presentation is rounded off with a glance at recent R&D activities at INKA related to micro-optical elements for advanced illumination systems [5-7].

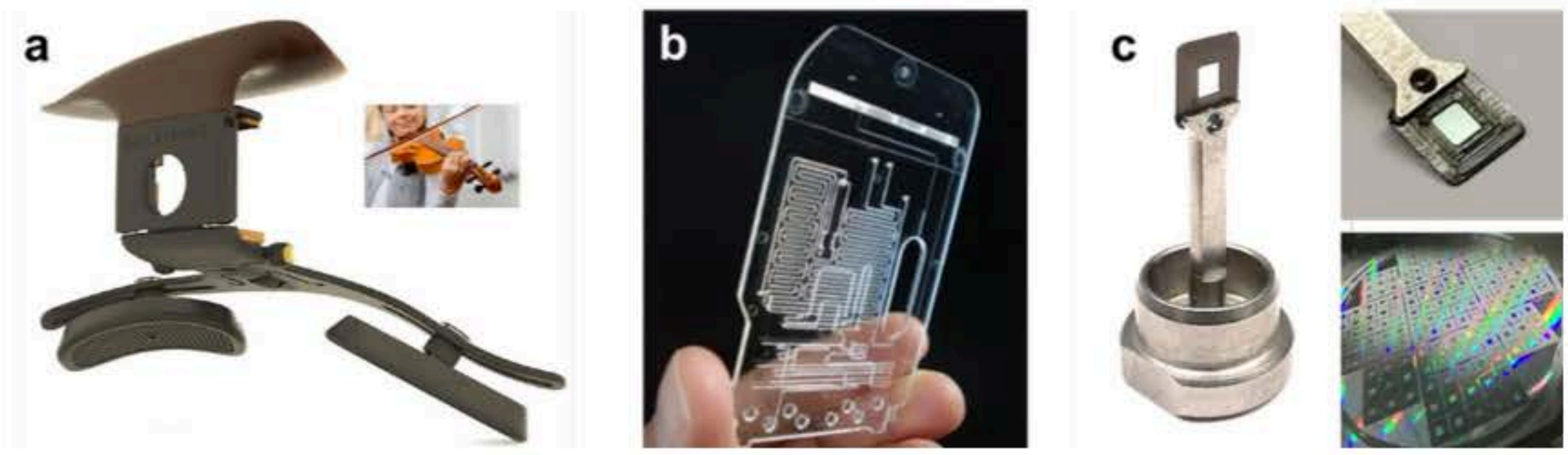

Figure 1: a) Violin support comprising surface textured TPE pads with improved haptics and anti-slip properties, (commercialized by Dolfinos) b) injection molded microfluidic device for multiplex whole blood analysis, (commercialized by Claros Diagnostics, acquired by OPKO) c) polymer supports for protein crystallography, manufactured by NIL and 3D printing (commercialized by SwissCI)

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2. Claros Diagnostics is acknowledged for direct funding of our R&D activities over many years. A big thanks goes to Vincent Linder and his team for keeping the faith and going all the way to the industrialization with us.
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Modeling the replication of submicron-structured surfaces by micro injection molding

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The replication of submicron surface structures by micro injection molding is a crucial factor in achieving advanced functionalities, such as antimicrobial resistance, in mass-produced plastic products. In this work, the replication quality of submicron-scale Laser-Induced Periodic Surface Structures by micro injection molding of PLA, PBAT/PLA, and PP was investigated. A multi-scale approach was adopted to model polymer replication at the submicron scale. A numerical model analyzes the polymer behavior in the mold macro cavity and determines the boundary conditions for the filling of the submicron structures. Then, the replication of the mold topography is calculated considering topographical parameters, polymer rheology and thermal behavior, and the mold surface energy, which was modified by depositing an atomic layer of alumina on the steel surface structures.

The modeling approach was validated against injection molding experiments, in which the mold temperature was varied due to its significant and well-known influence on replication. The experimental results show that LIPSS replication is mainly affected by polymer selection and mold temperature.

The predicted replication is very accurate, with a maximum error of 8%, and the analytical model is sensitive to the variations of polymer selection and mold temperature, thus being able to capture the effect of these processing variables. The comparison of the contributions of viscosity and capillarity to the air pressure, at the end of the replication process, shows that polymer replication is mainly viscosity driven, as the viscous pressure drop is generally higher than the capillarity pressure.

The effect of mold surface wettability is also considered in the analytical model: higher contact angles lead to negative capillarity pressure, thus counteracting the filling of the submicron cavities. The Al2O3 coatings increased the contact angle for PLA, thus decreasing the capillarity pressure. Conversely, the trend is opposite for the PBAT/PLA blend, thus leading to higher wettability and higher pressure. The significantly lower contact angles observed with PP resulted in a negligible effect of the capillarity pressure.

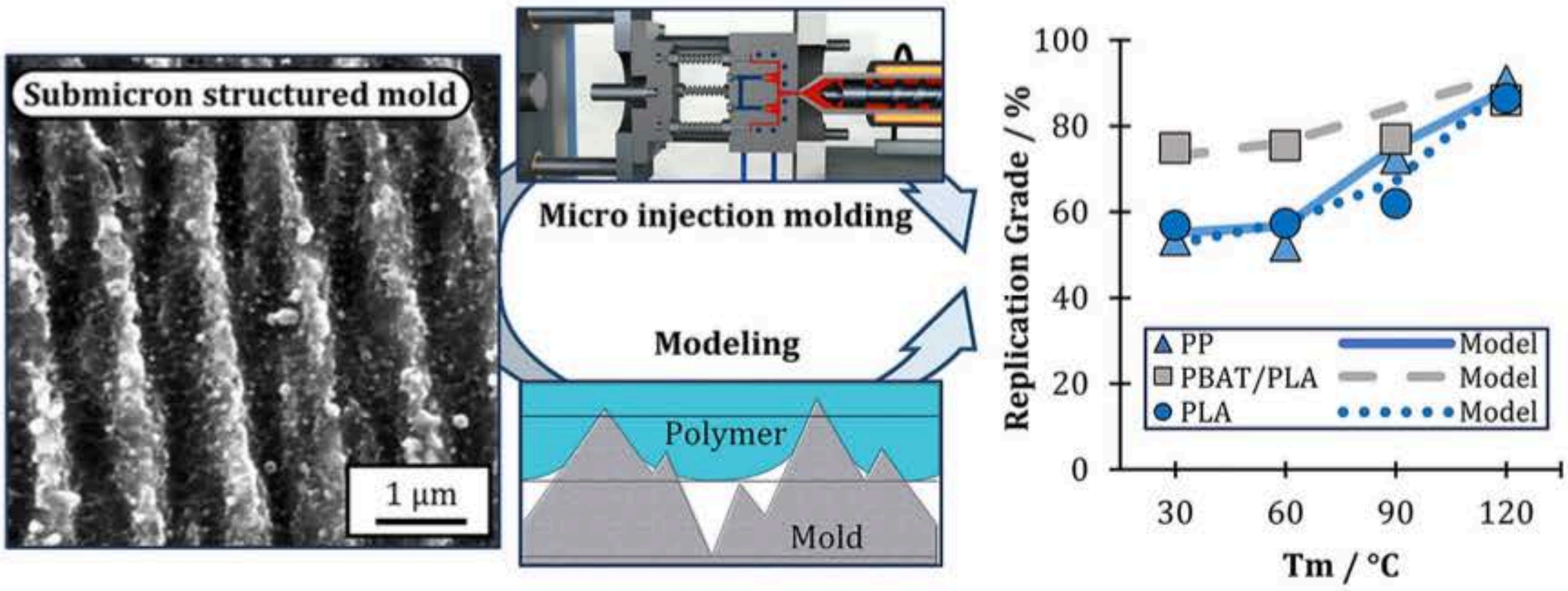

Figure 1: A novel multi-scale numerical model for submicron scale polymer flow was developed. The model considers topographical parameters, polymer thermal and rheologic properties, and mold surface wettability.

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Nanomedicine today and tomorrow

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Nanomedicine is defined as the application of nanotechnology to achieve innovation in healthcare. On one side, the term nanomedicine describes a novel class of products, nanopharmaceuticals and nanoimaging agents, mostly based on nanoparticles. On the other side, the term nanomedicine is used for a multidisciplinary field of research, where nanotechnology is applied to healthcare and can, together with other technologies, have an impact on all stages of the care cycle, from prevention to home care. Nanomedicine has a wide range of applications, as diagnostics, medical imaging agents, nanotherapeutics, vaccines and in regenerative medicine.

Europe's nanomedicine ecosystem has since more than a decade been shaped and supported by the European Technology Platform on Nanomedicine, ETPN [1]. ETPN was created in 2005 as a common initiative from industry and the European Commission. Its mission is to shape and support the ecosystem of nanomedicine in Europe by defining R&D priorities, mobilize stakeholders and foster translation. Since 2015, it is an independent association under French law 1901. ETPN has built the nanomedicine translation hub [2], a central instrument of ETPN to support and accelerate the development of the best nanomedicine projects through its three main pillars addressing the three main challenges during translation, mentoring, preclinical characterization, and scale-up and GMP manufacturing.

During the last years, the European health technology environment has undergone a substantial change. A new industrial ecosystem, cross industries/cross business models, where the medical device, pharma, biotechnology and ICT sectors are joining forces, also demands a new ecosystem of key enabling technologies. When the science-driven revolution, including nanomedicine, and the technology-driven revolution work hand in hand, these disruptive technologies will be able to revolutionize healthcare. The future of nanomedicine lies in adapting to this new environment and be part of a landscape fostering convergence of technologies. ETPN is now in the lead of shaping the HealthTech4EU Alliance, pathing the way to address unmet healthcare needs with innovative nanotechnology-based solutions in a cross-key enabling technology approach.

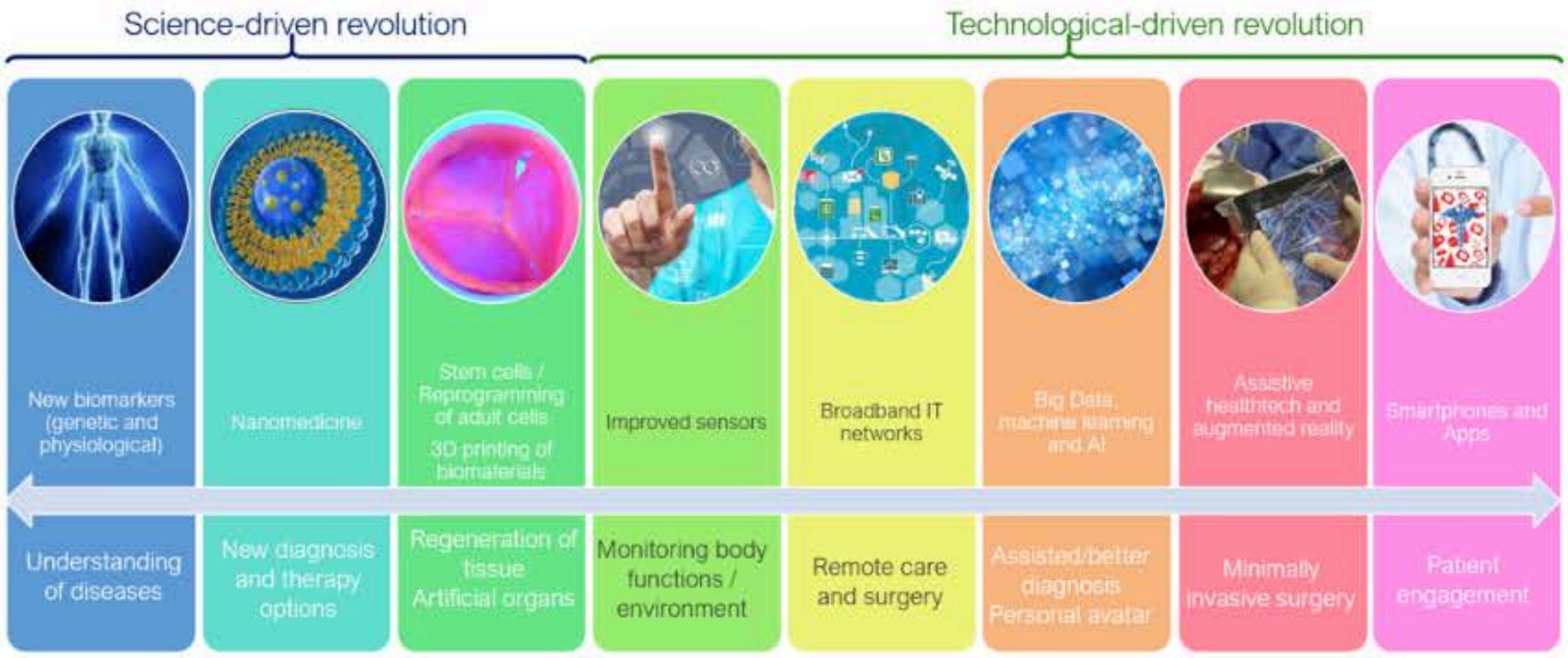

Figure 1: Cross-technology landscape fostering convergence of technologies, where science- and technology-driven revolution work hand in hand to revolutionize healthcare.

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3D Printing Medical Devices Designed Towards Optimal Soft Tissue Interaction

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The UCD Medical Device Design Group is focused on developing platform medical device technologies, offering smart ways to deliver next-generation therapeutics through minimally invasive approaches. A key aspect to this is research is to optimise the interaction, including penetration and/or adhesion of medical devices to soft tissue.

The interface between host and implant is a key predictor of device performance. When seeking to attach or integrate medical devices with host soft tissue, current methods of fixation and integration can lead to suboptimal results. There is a reliance on (1) chemical-based adhesives, which require tissue-specific reactive chemistry and subsequent risk of an inflammatory response, or (2) mechanical methods of fixation (sutures or staples) which can induce significant local tissue damage and associated increased risk of infection.

In devising solutions, we turn to nature for inspiration for designs that can penetrate and/or adhere to tissue in a controlled and minimally invasive fashion. 3D printing is used as a key enabling technology, due to inherent design freedom that it offers.

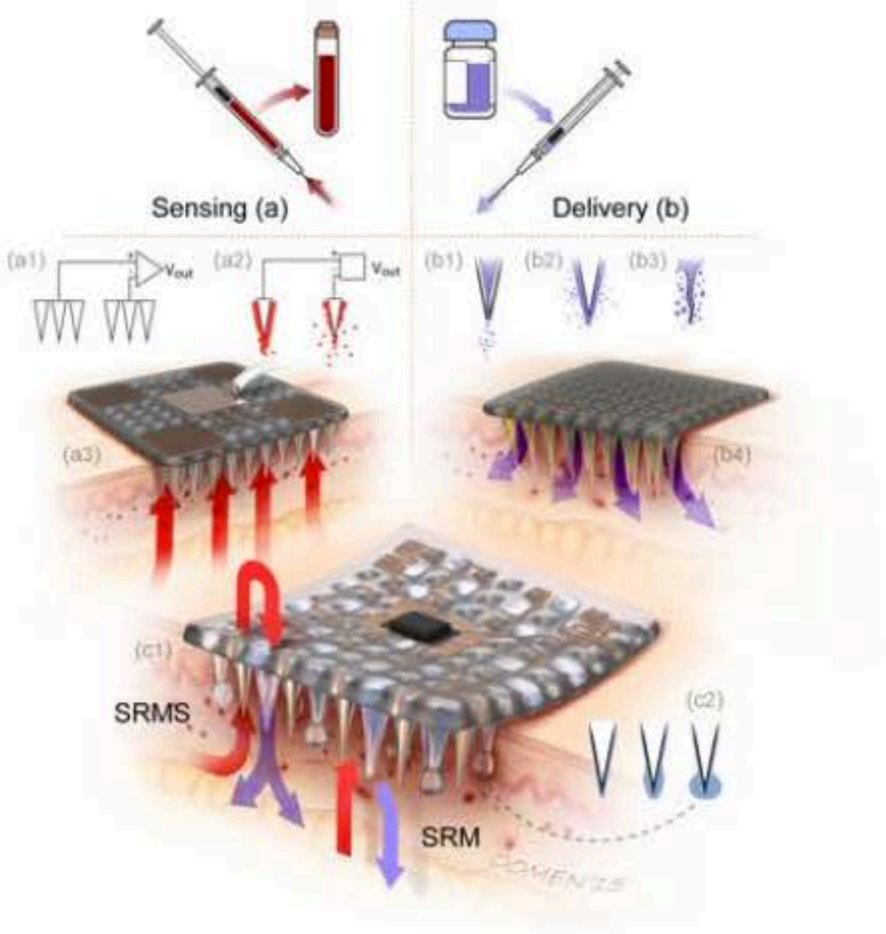

Figure 1: Future Direction of Microneedle Technology towards biofunctional systems.[1]

Here, we present examples of novel interfacing geometries optimised for tissue adhesion and integration respectively. Firstly, microneedle technologies under development in the UCD Medical Device Design Group are described [2-4], including configurations that achieve robust and reversible mechanical adhesion to skin. These platforms can be used for 'click-on' drug delivery and biosignal sensing applications. Secondly, utilising a novel direct ink additive manufacturing approach, we have produced soft flexible silicone-based implants with a unique surface topography designed to minimise fibrosis and control the wound-healing response [5]. These geometrical conformations create platforms for optimal tissue fixation and integration for a broad range of medical devices.

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Biopolymer-based tough hydrogels for additive manufacture

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As the dominant component form of cells, extracellular matrix, tissues, and organs, hydrogels have been used in various biological and biomedical application areas, including wound dressings, drug delivery vehicles, tissue engineering scaffolds, soft robotics, and contact lenses [1]. However, the high-water content of traditional hydrogels results in low mechanical properties, especially low toughness, making them unsuitable for most physiological load-bearing situations. Recently, intensive efforts have been devoted to improving the toughness property of hydrogels, such as constructing more homogeneous hydrogel networks, introducing more reversible or irreversible bonds in the original hydrogel framework, and introducing structures in the hydrogel with folding, sliding, or high cross-linkage points. However, the above-mentioned tough hydrogels not only inevitably use bio-toxic monomers, crosslinkers or initiators, but also have a highly complex preparation process [2]. Hence, a new tough hydrogel with simple preparation process and good biocompatibility has a high potential for bio-application.

In this work, we hypothesized that the introduction of a single network with distinct chain lengths would be equally effective in improving the toughness of the hydrogel. Specifically, two structural features of tough long and short chain (LSC) hydrogels were proposed in particular: (i) the skeleton of rigid hydrogel networks formed by short chains is relatively homogeneous, and (ii) some flexible long chains are connected with the rigid network skeleton. Here we report a universal example (Figure 1) of LSC-hydrogels composed of biocompatible materials including thiolated hyaluronic acid (HA-SH), acrylated hyaluronic acid (HA-A), polyethylene glycol dithiol (PEG-DSH), and polyethylene glycol diacrylate (PEG-DA). In detail, PEG-DSH and PEG-DA act as long chains in the hydrogel network, while the HA-A and HA-SH act as short chains.

Remarkably, the combination of long and short chains results in a multi-fold increase in the limit stress and toughness of the hydrogel, while retaining the advantage of extremely simple and safe in-situ gel formation. But, more importantly, this simple and effective criterion for LSC-hydrogels can be extended to numerous classical single network (SN) - hydrogel systems and provide new directions for the design and preparation of tough SN-hydrogels.

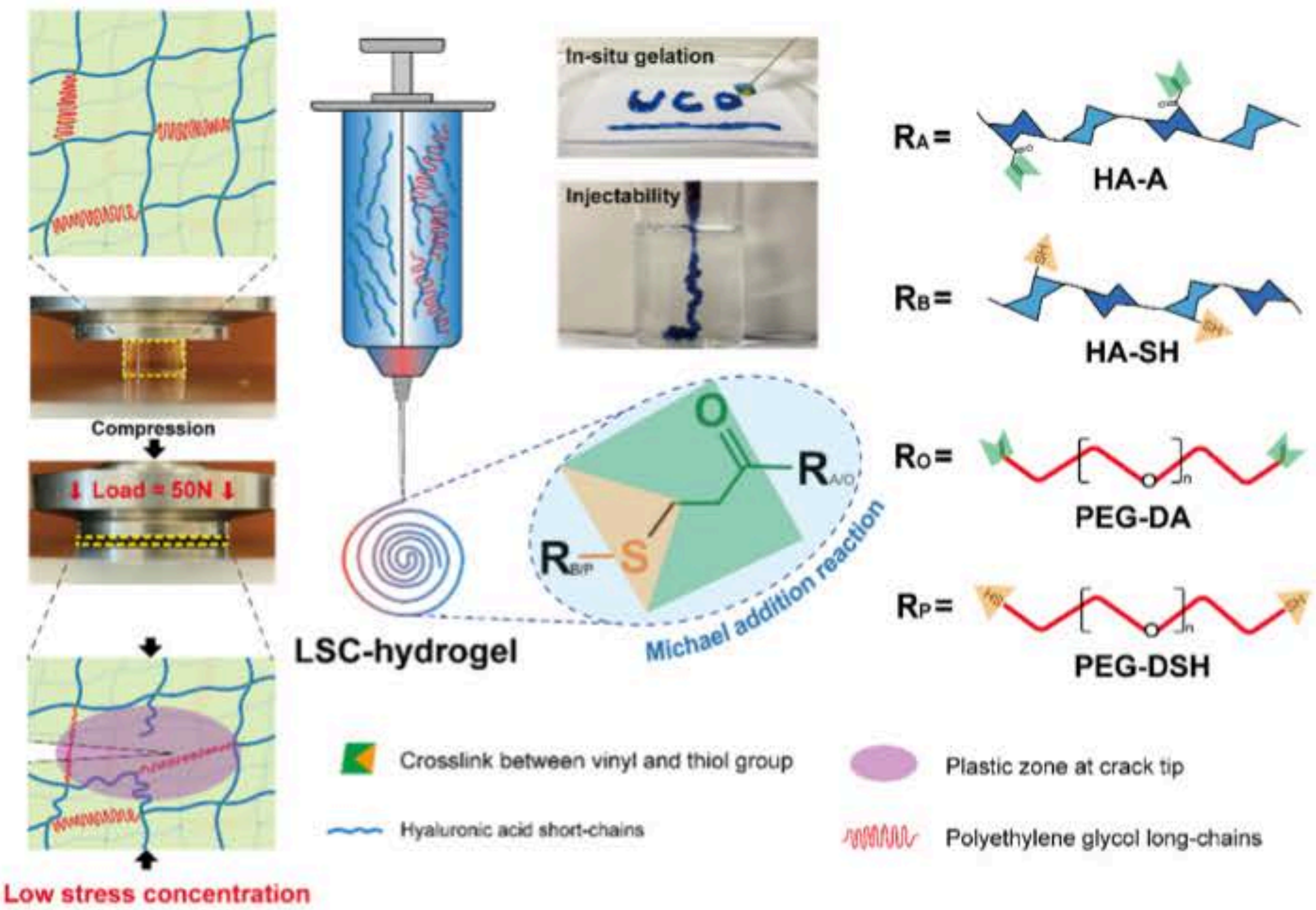

Figure 1: Preparation routes and chain fracture under compression of LSC-hydrogel

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ABSTRACTS FOR ORAL PRESENTATIONS

Manufacturing of plastic microfluidics: Translating microfluidic devices from laboratory prototyping into scale-up production

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Transforming lab research into a sustainable business is becoming a trend in the microfluidic field. However, there are various challenges during the translation process due to the gaps between academia and industry, especially from laboratory prototyping to industrial scale-up production, which is critical for potential commercialization [1,2]. In this presentation, based on our experience in collaboration with stakeholders, e.g., biologists, microfluidic engineers, diagnostic specialists, and manufacturers, we aim to share our understanding of the manufacturing process chain of plastic microfluidic cartridge from concept development and laboratory prototyping to scale-up production, where the scale-up production of commercial microfluidic cartridges is highlighted. Suggestions from the aspect of cartridge design for manufacturing, professional involvement, material selection, and standardization are provided in order to help scientists from the laboratory to bring their innovations into pre-clinical, clinical, and mass production. We hope a manufacturing mindset is built in the early stage of the development period and more attention will be paid to a good design and a robust protocol. Also, collaborations between various disciplines are always encouraged to establish the standardization system and accelerate the commercialization of microfluidics.

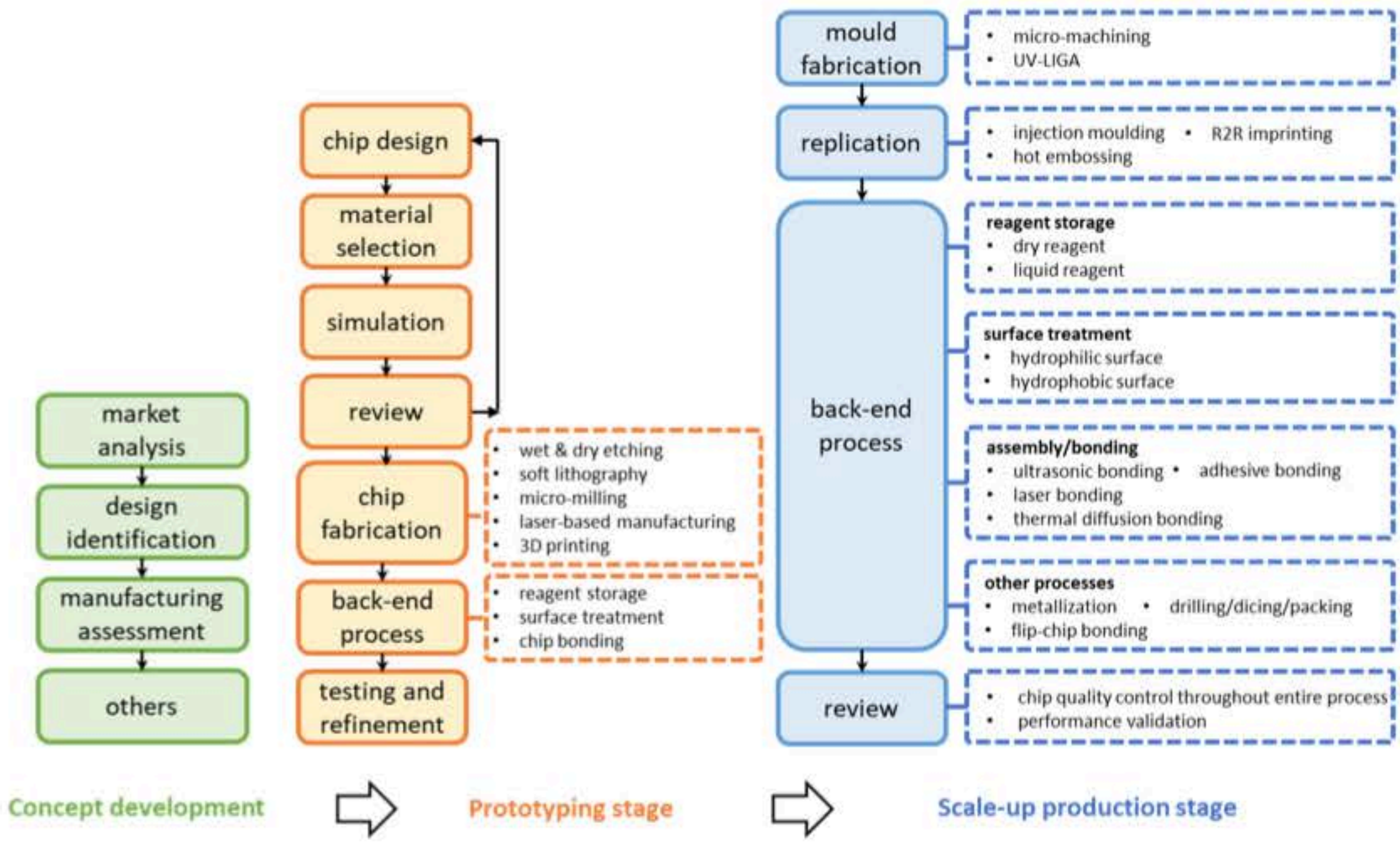

Figure 1: Development process of microfluidic devices in prototyping and scale-up production stages

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Surface Micro structuring injection moulding using soft tooling

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The soft tooling process chain consists of two major process steps, i.e., additive manufacturing of a soft tool followed by injection moulding [1]. A pair of moulds produced by vat photopolymerization can last up to 1000 cycles in a typical injection moulding process [2]. This process is suitable for prototype productions and pilot productions due to improved geometrical freedom, short lead time and low cost.

In this research, soft tooling was investigated for micro structuring on injection moulded surfaces. Compared with conventional machining methods, additive manufacturing enables fabrication of micro features on 3D surfaces and freeform surfaces. Applications that applied soft tooling for micro structuring on different surfaces are presented.

It is possible to use metal inserts on a soft tooling mould, in order to achieve dimensions that is beyond the capability of current 3D printing. Difference of expansion coefficient between metal and photopolymer resin did not lead to failure during injection moulding.

Not only polymer injection moulding, but metal powder injection moulding was investigated as well using soft tooling. A water-soluble mould produced by additive manufacturing enables the feasibility of powder injection moulding based routes for production of complex 3D geometries. It is demonstrated in this study that micro features like micro pillars and holes can be obtained on the surfaces [3].

Soft tooling, where polymer additive manufacturing is used for mould fabrication, has brought new possibilities with respect to obtainable geometries for complex mould parts and micro structuring on surfaces. This process is suitable for small batch production, pilot production or prototype production.

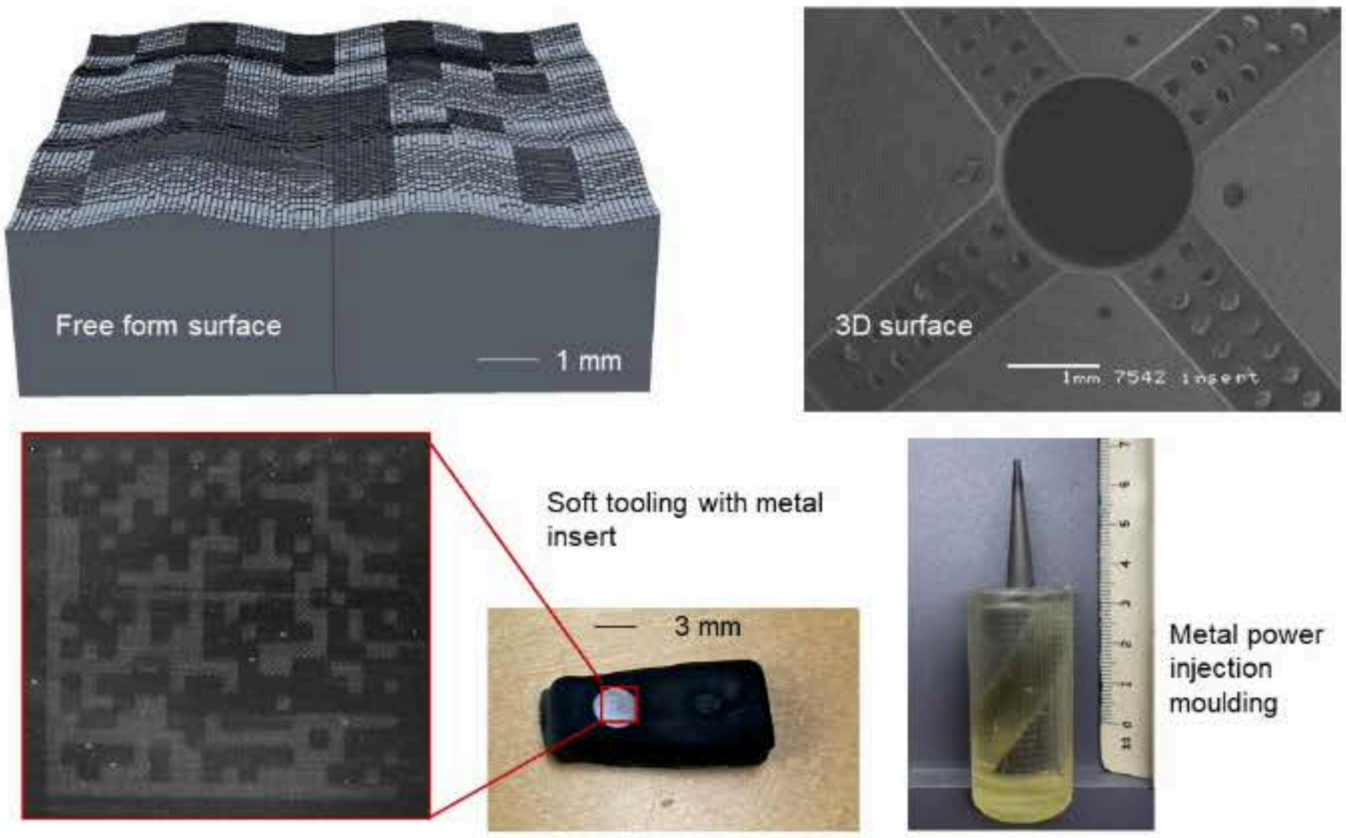

Figure 1: Micro structured surfaces fabricated by soft tooling injection moulding

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Synthesis of two-dimensional WS_2/nickel nanocomposites via electroforming for high-performance micro/nano mould tools

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In polymer micro/nanofabrication, such as microinjection moulding, micro hot embossing and nanoimprinting, friction-induced surface distortion and adhesion-induced surface damage are the main causes of product failure [1]. The micro/nano mould lifetime is also limited by its low hardness and wear resistance [2].

To reduce the adhesion and friction between polymer and mould surfaces during demoulding, we have used tungsten disulfide (WS_2) nanosheets to fabricate high-performance nickel/WS_2 nanocomposite mould using electroforming. However, the aggregation of WS_2 nanosheets in the electroforming solution is a critical issue that influences the mechanical and tribological properties of the mould. In this study, we first propose a new strategy of combining anionic surfactant sodium dodecyl sulfate (SDS) and cationic surfactant cetyltrimethylammonium bromide (CTAB) to achieve uniform dispersion and incorporation of WS_2 nanosheets in the electroformed nickel mould. Our results indicate that appropriately designing the structure of CTAB-SDS complex can achieve a stable WS_2 dispersion, contributing to the uniform co-deposition of WS_2 nanosheets into nickel mould. The combination of high concentration of CTAB and SDS (1.0 g/L CTAB and 1.0 g/L SDS) significantly improved the dispersibility and incorporation of WS_2 into the nickel matrix, compared to individual SDS or CTAB. Consequently, the maximum hardness enhanced by 350% from 284 HV for pure nickel to 1280 HV for nickel/WS_2 nanocomposite mould, along with the coefficient of friction (COF) against the polymethyl methacrylate (PMMA) pin reducing from 0.75 to 0.31. It is also found that CTAB promotes particle encapsulation while SDS improves the particle dispersion but cannot control the particle incorporation. The surface wettability of nickel/WS_2 mould altered to hydrophobicity from hydrophilicity of nickel mould, where the adhesion-induced wear caused by polymer pin significantly reduced. Moreover, the surface roughness did not change much with the incorporation of WS_2 into the mould, which is acceptable for mould applications. Finally, the nickel/WS_2 nanocomposite mould was successfully fabricated via electroforming and its self-lubricating properties was validated by micro hot embossing PMMA microfluidic chips with good surface quality.

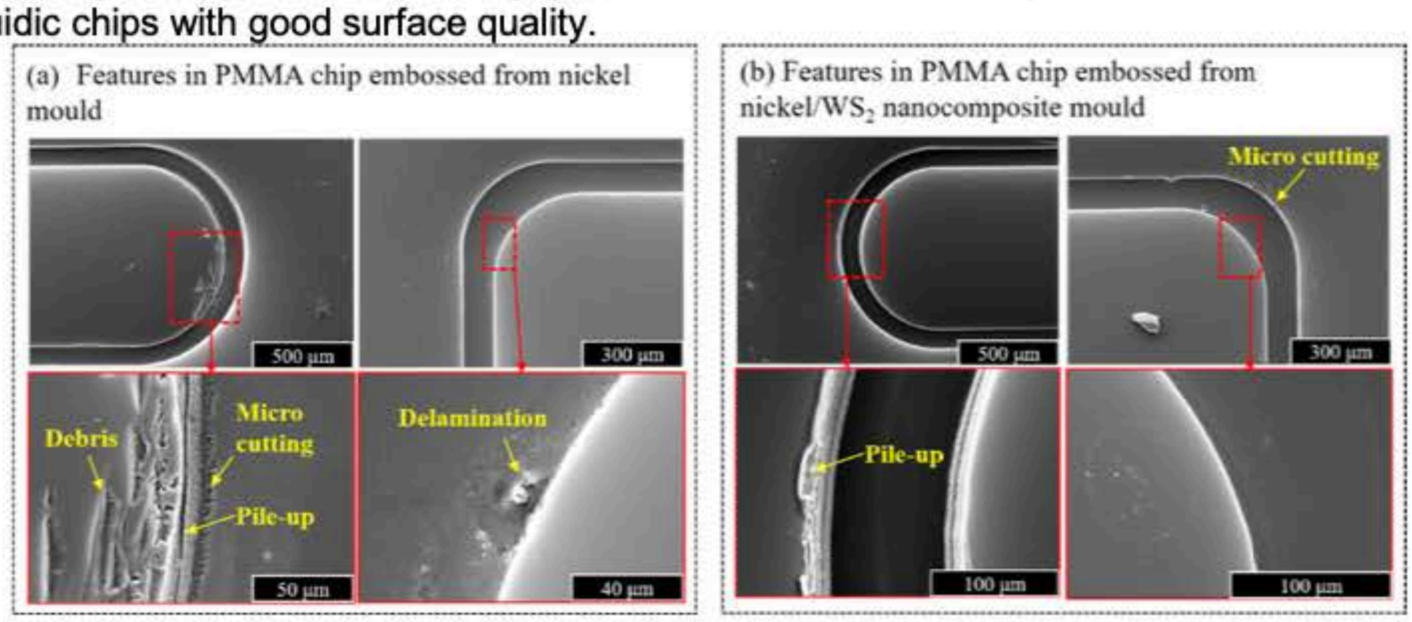

Figure 1. Surface morphology of features on the embossed PMMA microfluidic chips from (a) nickel mould and (b) nickel/WS_2 composite mould.

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Engineering of wetting properties for polymer surfaces

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Functional surfaces with tailor-made wetting properties for selected applications can be engineered by employing top-down fabrication methods, comprising master origination in Si, electroforming a mold master in Ni, and replication in polymeric materials by highly scalable industrial processes such as injection molding[1] or roll-roll extrusion coating[2].

In this talk I will discuss the basics of surface wetting for nanostructured surfaces. The starting point will be a model, where a minimization of Gibbs free energy is employed to predict the contact angle and further elaborated by also including the work done by moving triple-phase line against the Laplace pressure. The discussion will be supported by examples of wetting properties for nanotextured polymeric surfaces.

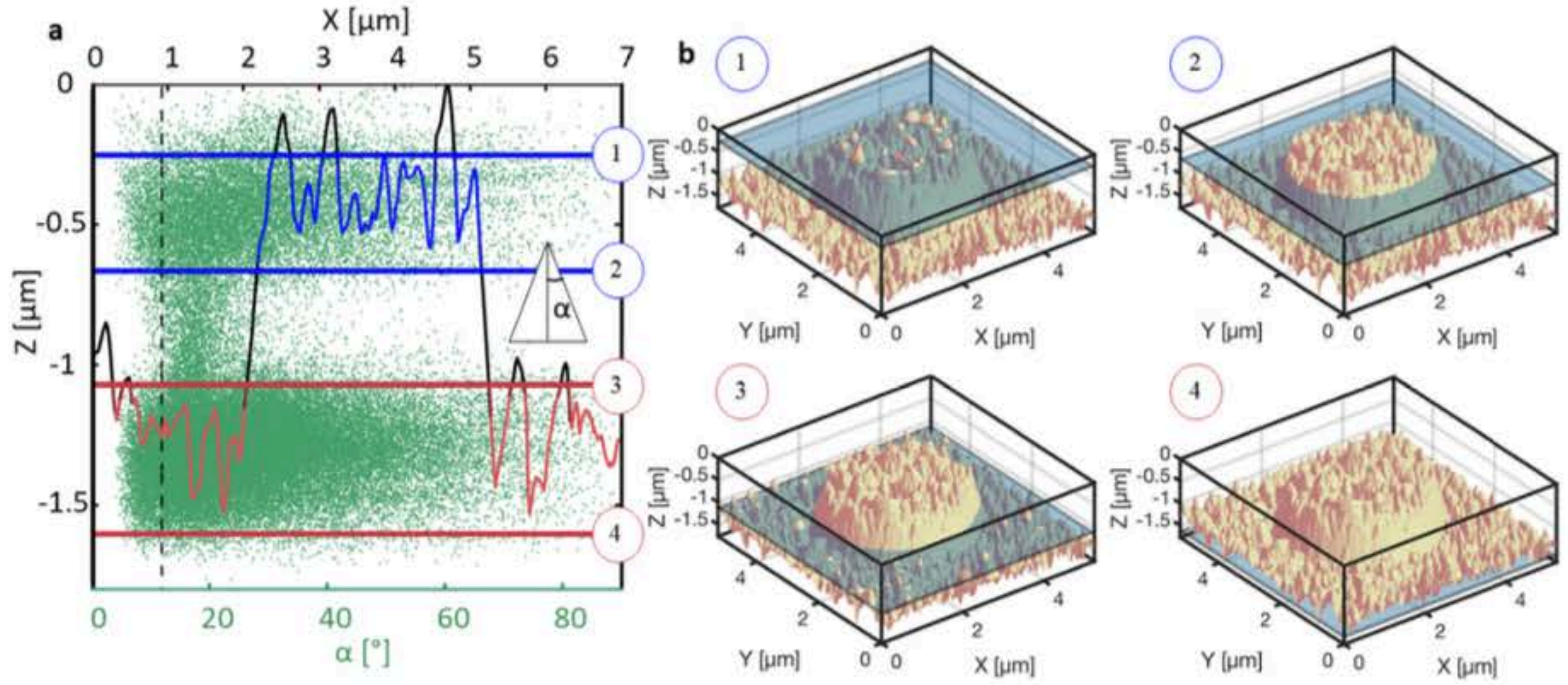

Figure 1: Reproduced from ref[3] with permission creative Commons Attribution 4.0 International License. © The Authors 2018. **a)** Half-opening angles α as the function of the depth Z into the pattern obtained from atomic force microscopy (AFM) for a hierarchical micro/nanostructured polymer surface with predicted wetting levels based on a Laplace pressure model. **b)** The 3D representation of one of the micro-pillars recorded by AFM for each of the four liquid levels 1-4.

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Fast Electrical Impedance Spectroscopy for Microfluidic Singe Cell Characterization and Counting

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Microfluidics benefits greatly from electrical impedance measurements when it comes to measurement speed and sensitivity. Here, we present a typical electrical impedance spectroscopy setup and includes measurement results from an operating microfluidic system. Thanks to the differential current measurement scheme to cancel the noisy microfluidic background, the HF2LI Lock-in Amplifier can clearly resolve individual flow processes within a 5 µs timeframe. Simultaneous multi-frequency measurements further unveil a full picture of the dielectric property of particles under test.

The result confirms that the setup can determine the size distribution of micrometer beads, as well as the generation rate and velocity of water-in-oil droplets, shown by the figure below. The HF2LI enables the fast detection and discrimination of individual cells or particles in flow at a speed unavailable to camera-based solutions. Not just saving the cost, this label-free technique has a high sensitivity thanks to the current (impedance) measured at different frequencies. Besides flow cytometry for counting and sorting of cells or droplets, which can be employed in lab-on-a-chip and point-of-care applications, the setup also holds future potentials in quality control in the food industry, protein engineering, and blood analysis.

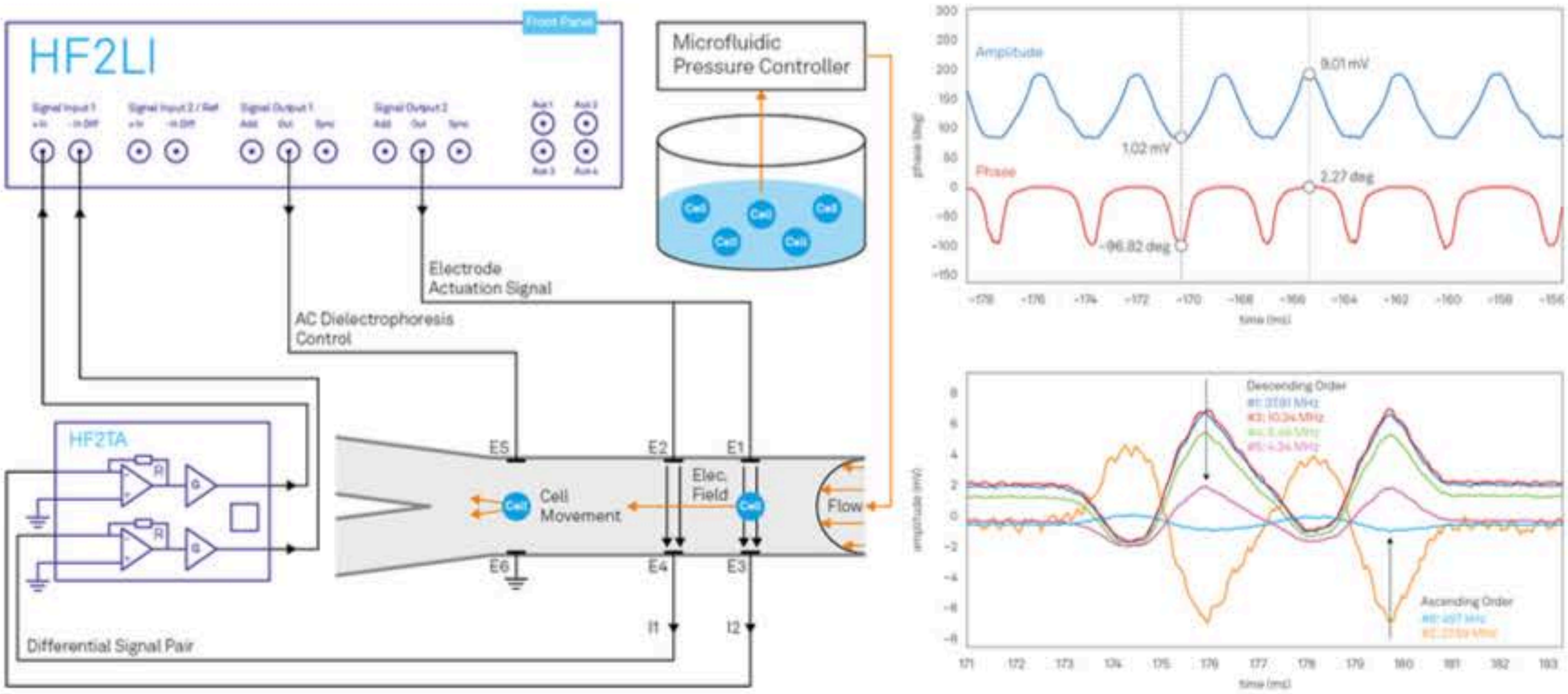

Figure 1: Sketch showing the Zurich Instruments HF2LI Lock-in Amplifier measuring the current as cells pass through differential electrodes in a microfluidics channel. The setup can be used to determine the size and speed of them, followed by real-time sorting using AC dielectrophoresis.

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Injection Moulded Microfluidic Lab on a Disc Platform for Extracellular Vesicle Analysis

***Damien King**[1*]*, *Adam Murphy[1]*, *Josh Fallon Doran[1]*, *Raphaela Ferreira[1]*, *Rosheen Speier[1]*, *Zoe Deignan[1]*, *Abidemi Olayinka[2]*, *Imen Gdara[2]*, *Roya Hakimjavadi[2]*, *Toni Christopher Voebel[3]*, *Marvin Berger[3]*, *Hendrik Naumann[3]*, *Daniel Reibert[3]*, *Yanis Mouloud[4]*, *Verena Börger[4]*, *Bernd Giebel[4]*, *Paul A. Cahill[2]* *and Jed Harrison[1]*

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The **EVPRO (E**xtracellular **V**esicles **P**romoted **R**egenerative **O**sseointegration**)** project aims to counteract the shortened lifetime and to reduce the risk of inflammation of hip revision prostheses. To this end, the project team are developing a novel bioinspired adaptive coating for hip revision endoprosthesis, which is able to control inflammation at the original anatomical location of the removed endoprosthesis and promote bone regeneration. They seek to achieve this by safe integration of human mesenchymal stem cell derived extracellular vesicles (MSC-EVs) into a smart biodegradable hydrogel which is absorbed into the micro pores of a TiO_2 coating on the surface of conventional titan endoprosthesis (Figure 1(a)).

Microfluidic lab on a disc (LoaD) technology has been selected as a key method for performing quality control analysis on the MSC-EVs generated in the project. The designed LoaD will select the key MSC-EVs based on their size and biomarker expression properties (CD63, CD81). The LoaD technology has undergone evaluation under rapid prototyping techniques and has been transferred to injection moulding based pilot scale production. Automated assembly techniques have also been deployed in the pilot scale production phase. The injection moulded LoaD platform has been evaluated using EVs produced from both static and dynamic cell culture conditions and the LoaD is also suitable for system integration with bioreactor systems for in-line sampling and measurements (Figure 1(b)).

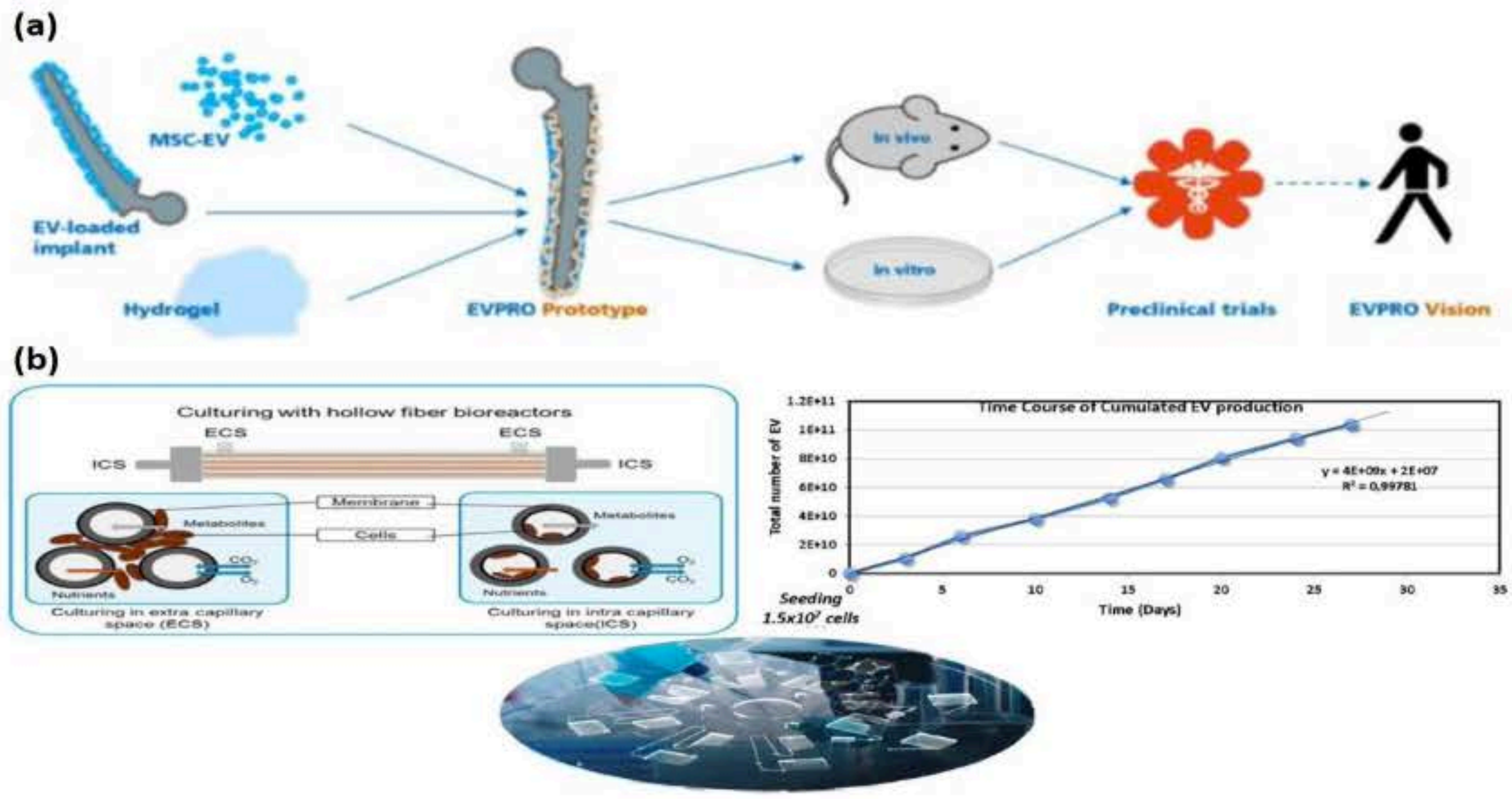

Figure 1: (a) EVPro Project Workflow. (b) LoaD technology deployed for EV quality control analysis.

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POC Microfluidic Platform Technologies: Bridging the Translational gap

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The translation of concepts and early stage development of automated bioanalytical devices beyond the prototyping scale, is critical in the growth and market acceptance of such technologies, especially in the Point-of-care/need space (POCT). FPC@DCU has developed platform technologies in this space leveraging unique know-how and flow control technology, in the areas of planar and centrifugal microfluidic devices [1]. We present here some key aspects of the development of scalable devices that employ precision polymer injection molding, functional polymers and hybrid integration methods among others.

Sample to answer integration is key in the development of POCT devices. We have developed centrifugal microfluidic devices that possess unique advantages (*e.g.*: No external pumps or interfacing required; flexibility with highly multiplexed assays; lack of bubbles among others) for the development of POC devices with several applications demonstrated in the areas of Human/Veterinary diagnostics [2,3], Environmental sensing, Food industry, BioPharma production and monitoring among others. Prototyping of such devices typically 3D printing, layer-by-layer and/or laminate manufacturing and assembly which is cost-prohibitive, time consuming, and prone-to-failure at larger scales. To allow for scalability, we have developed a combination of technologies using precision polymer injection molding, pick-and-place, polymer films and roll-to-roll manufacture. We have deployed this technology to demonstrate a POC microfluidic platform that enables the detection of disease biomarkers for Sepsis triage using Immunoassays and intend to further develop this platform for other applications.

We are able to demonstrate the entire array of operations typical to bioanalytical devices (sample collection, interfacing, hybrid integration, flow control and detection capabilities) from design, prototyping into pilot-scale production.

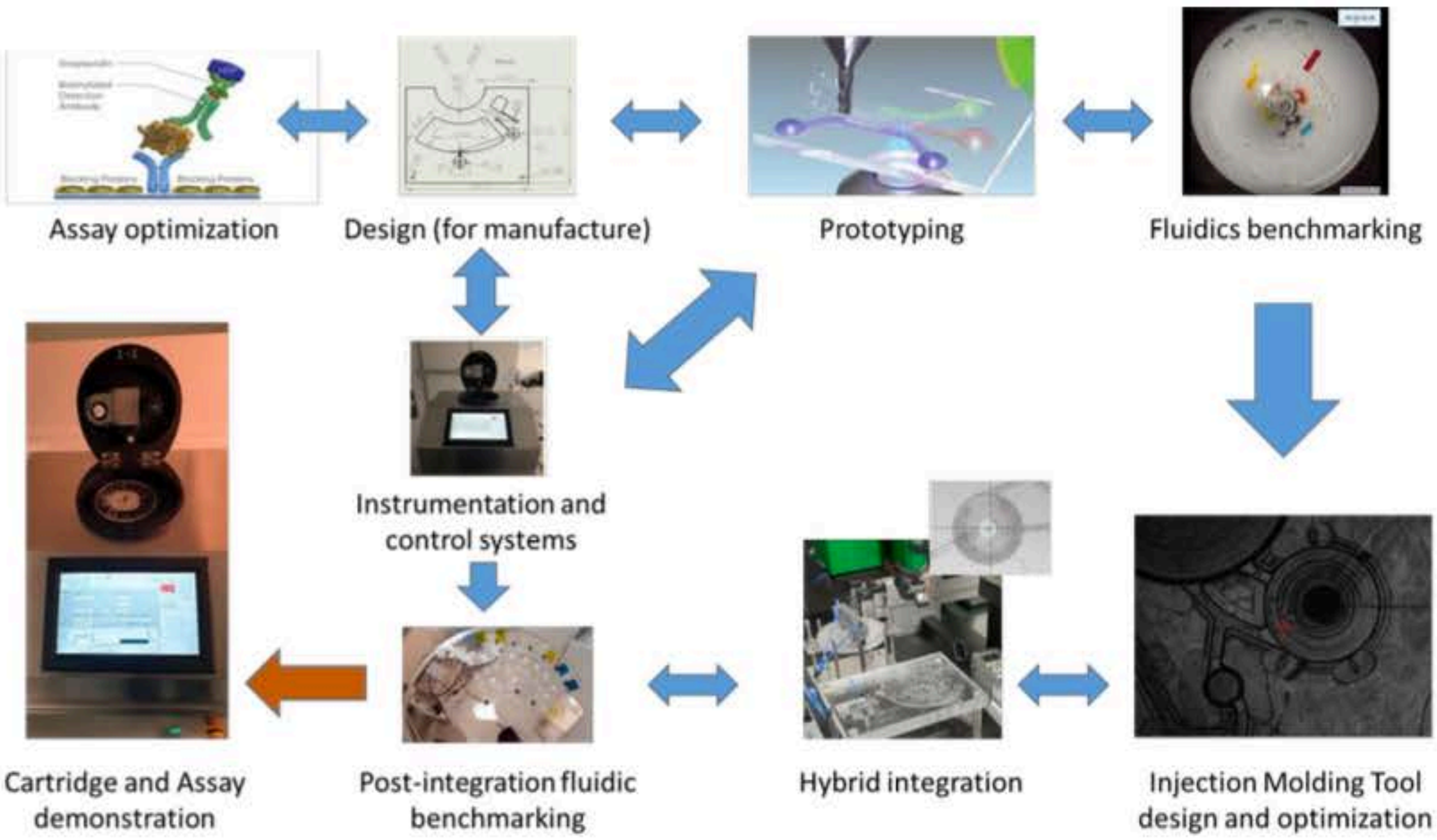

Figure 1: Critical stages of the development a POC device for scalability, in this instance for a multiplexed biomarker panel for Sepsis triage in critical patients, from design to a scalable pilot.

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Roll-to-roll Extrusion Coating – expanding the boundaries of roll-to-roll replication in thermoplastic materials

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Mass production using roll-to-roll processes is an expanding topic, where various techniques and materials are being used to achieve surface texturing on all levels from low nanometer up to millimeter range. Over the course of the last 10 years, a new groundbreaking technique of roll-to-roll imprint has been developed. Using roll-to-roll extrusion coating (R2R-EC), a true mass-manufacturing of micro- and nanostructures in thermoplastics can be achieved at industrially relevant production speeds, bringing some of the newest technologies onto the market.

Super repellant surfaces [1], plasmonic meta-surfaces [2] and biomedical devices [3] are some of the few examples of the functional surfaces achieved using this platform. To achieve these functionalities, surface structures spanning from nanometer scale up to millimeter scale have been demonstrated, as can be seen in Figure 1. High aspect ratio, challenging geometries, multi-level structures and slightly undercut structures have been demonstrated in various thermoplastic polymers like polypropylene (PP), polystyrene (PS) and cyclic olefine copolymer (COC). This study will touch upon the achieved high quality imprint results and will address the challenges and advantages connected to the roll-to-roll imprint process.

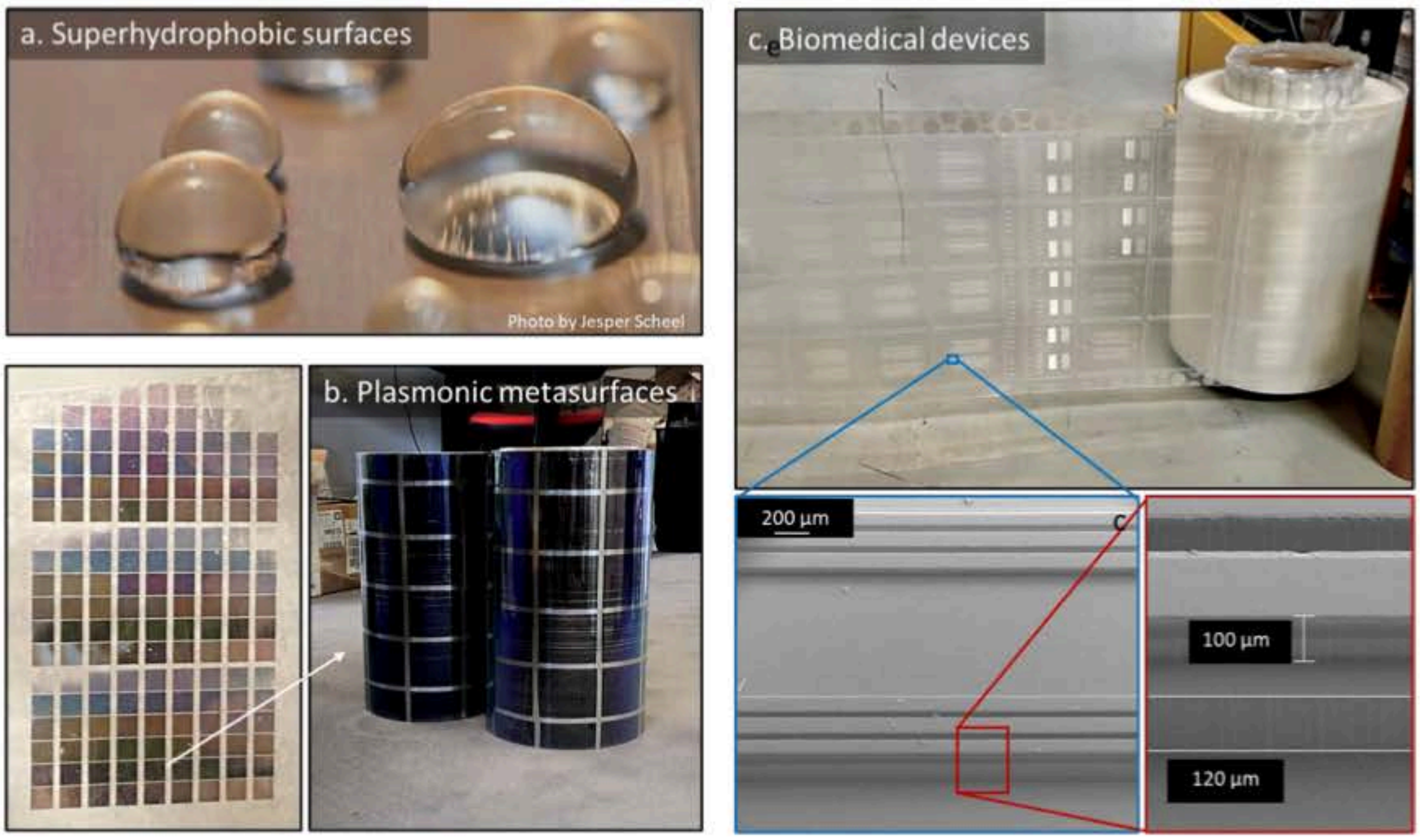

Figure 1: Examples of films imprinted using R2R EC: a. superhydrophobic surfaces, b. plasmonic metasurfaces for harvesting solar heat, c. biomedical devices on a reel, in the captions SEM images of the achieved structure with a two-step microfluidic channel with energy directors and the overall imprint depth of 220 µm.

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Shaping of mould tools manufactured by UV LIGA and 3d printing

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Fabrication of mould tools for replicating of polymeric features at the micro and nanometer scales involves precise and controlled manufacturing conditions. Both UV LIGA and 3d printing provide the capability to manufacture micro channels with varying densities (width= 20-300µms, depth= 50-300µms, and gap= 50-4000µms). However such manufactured features need post processing, especially for those that are 3d printed. Electrochemical polishing is a convenient process for cleaning, leveling and shaping of microfeatures[1, 2]. It involves metallic dissolution based on current density which is more intense on the peaks rather than in the recessed regions. In order to improve the quality and decrease the occurrence of demoulding defects [3](friction, wear and adhesion), shaping/ rounding of mould tool inserts is required.

In this paper micro channels of nickel and stainless steel manufactured by UV LIGA (width=20-50µms, depth=50µms and gap= 20-50ums) and 3d printing (width=100-300ums, depth= 100-300µms and gap=4000µms), as shown in fig 1(a) and (b), are electropolished using weak acids. The electrolytic bath was developed after doing a characterization study to optimize the key parameters of electropolishing voltage (V), current density (J), temperature (C), electrolyte, magnetic stirring (rpm) and inter-electrode gap (mm). Weak electrolytes were capable of shaping and electropolishing the microchannels of nickel and stainless steel, as shown in fig 1 (c) and (d) in order to augment mould tool life and performance.

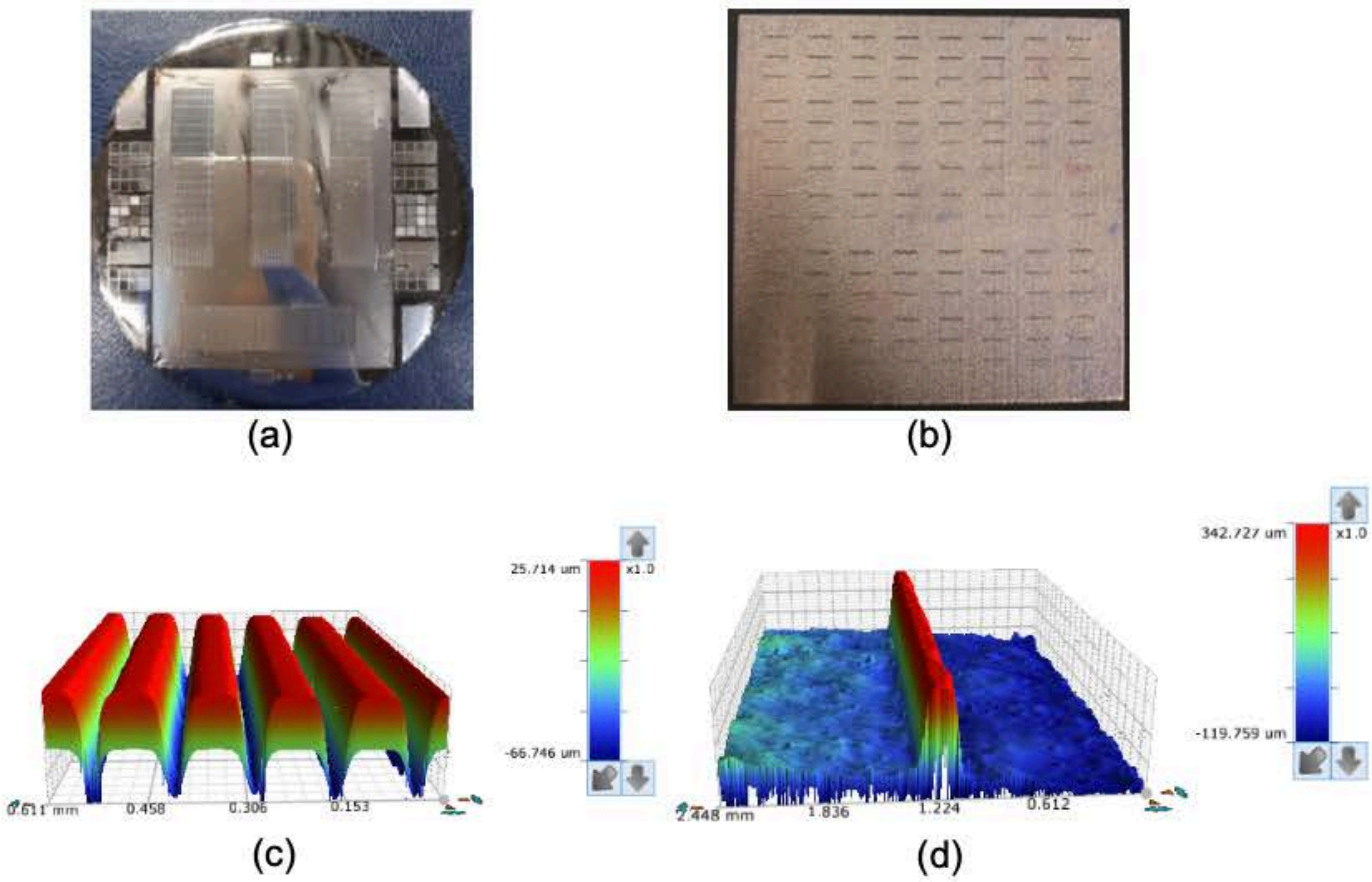

Fig 1: Microchannels and shaping details of UV LIGA and 3d printed features (a) UV LIGA Ni microfeatures, (b) 3d printed SS microfeatures, (c) shaped Ni microchannels, (d) shaped SS microchannels

Scalable mass manufacturing process for micro/nanostructure engineered plastic films with viral and microbial resistance

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Direct contact with contaminated surfaces in frequently accessed areas is a confirmed transmission mode of virus and microbial. To address this challenge, we have developed novel plastic films with enhanced effectiveness for deactivating virus (e.g. SARS-CoV-2) and microbial (e.g. *E. coli*) by means of functional coatings combined with nanopatterns. Those are achieved by two scalable fabrication techniques - ultrasonic atomization spray coating (UASC) and thermal nanoimprinting lithography (TNIL). Two strategies are customized to deal with two specific issues, (i) Integrating silver/copper nano-coatings with nanopatterns to efficiently deactivate the SARS-CoV-2 attached to the PE/PET packaging surface; and (ii) Integrating bio-based coatings with nanopatterns on PLA film to develop fully bio-based functional film that kills common bacteria like *E. coli*.

Results prove that nanopillars along could not impart films with sufficient antiviral and antibacterial properties. The films functionalised by silver nanoparticles coated nanopillars deactivate SARS-CoV-2 by up to 2 orders of magnitude within the first hour compared to untreated films, thus reducing the likelihood of transmission. Nanopatterns can enhance the antiviral effectiveness by increasing the contact area between nanoparticles and virus. The films decorated with tannins coated nanopillars show high antibacterial rate of over 98% against *E. coli* within 24 hours.

Significantly, the established process also considers the issue of scalability for mass manufacturing. A low-cost process for nanostructured antiviral and antibacterial films integrating ultrasonic atomization spray coating and thermal nanoimprinting lithography will be described in this presentation, along with details of the manufacturing process and functional assessment results. A subsequent in-depth investigation will consider the size, spacing, and shape of nanopillars, the type and concentration of coatings, and the scale-up and integration of these processes with manufacturing for optimal antiviral and antibacterial effectiveness.

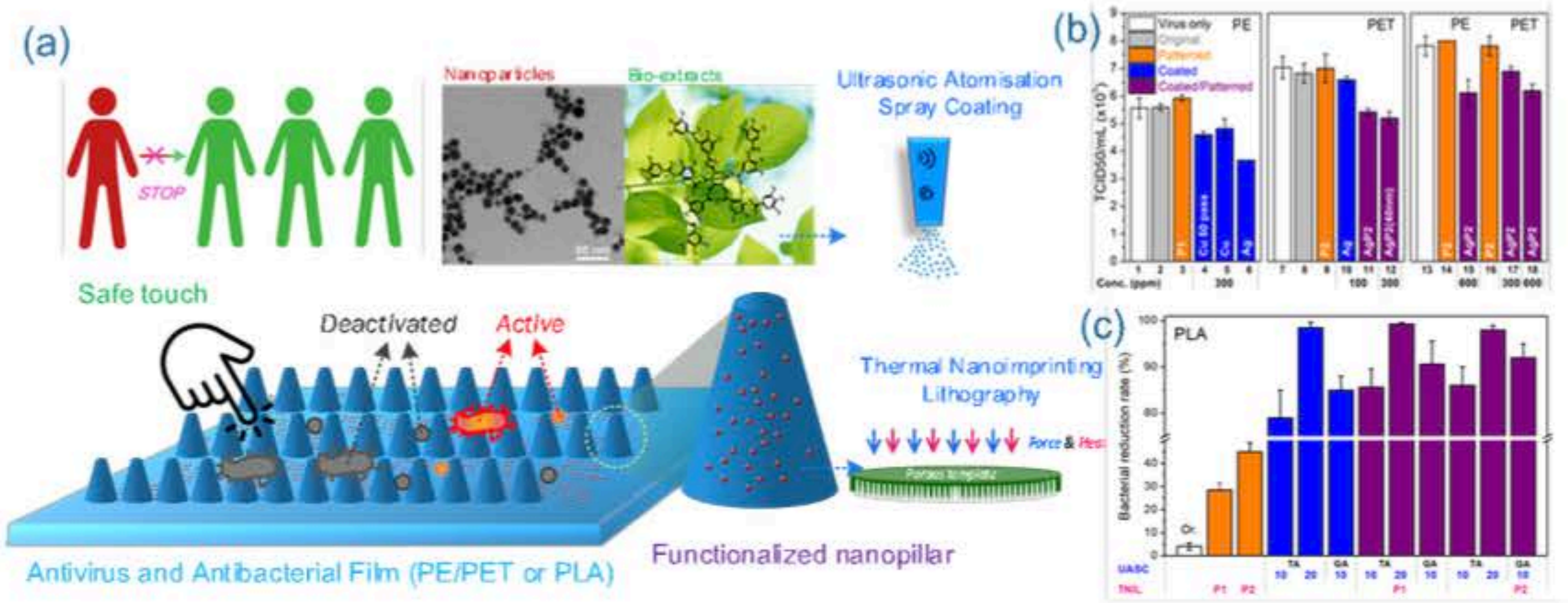

Figure 1: (a) Proposed strategy for antiviral and antibacterial films integrating functional coatings and nanopatterns, (b) Antiviral assessment, and (c) Antibacterial assessment.

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From wavefront sensors to retinal implants with polymers

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Structuring of optical materials at the micron- and nanoscale is vital across a vast range of sensing, illumination, and imaging applications. In adaptive optics, polymer lenslet arrays are used in Hartmann-Shack wavefront sensors to probe an incident wavefront and quantify aberrations. Local sensing of wavefront tilt can be accomplished in a variety of ways, including slanted optical fibres and quasi-resonant structures [1,2]. We have done initial studies with photoresist using UV lithography as well as with 2-photon 3-D printed Nanoscribe waveguides that allow detection of local wavefront tilt across an incident wavefront. Also, we have evaluated gold-on-glass to sample an incident wavefront globally via resonant excitation of surface plasmon polaritons [2]. The latter application converts phase to intensity without interferometry that with micron-sized polymer prisms, or with metagratings at the nanoscale, will ultimately allow probing of optical aberrations across a wide spectral range. This is vital for exoplanet astronomy, microscopy, as well as for ophthalmic retinal imaging and vision simulation. Finally, we report on waveguide structures in patterned photoresist that may be applied as a photoreceptor phantom on retinal implants used to combat blindness in retinitis pigmentosa patients [3]. The structure can screen against intraocular scattering of light and thereby enhance contrast and visual acuity. This is achieved by their angular-dependent coupling efficiency widely known as the Stiles-Crawford effect of the first kind in visual optics. With high resolution and high aspect ratio, polymers offer attractive biomedical possibilities where traditional optical glass materials are challenged. This is also being exploited in a wide range of intraocular lenses that are used in the surgical treatment of cataracts.

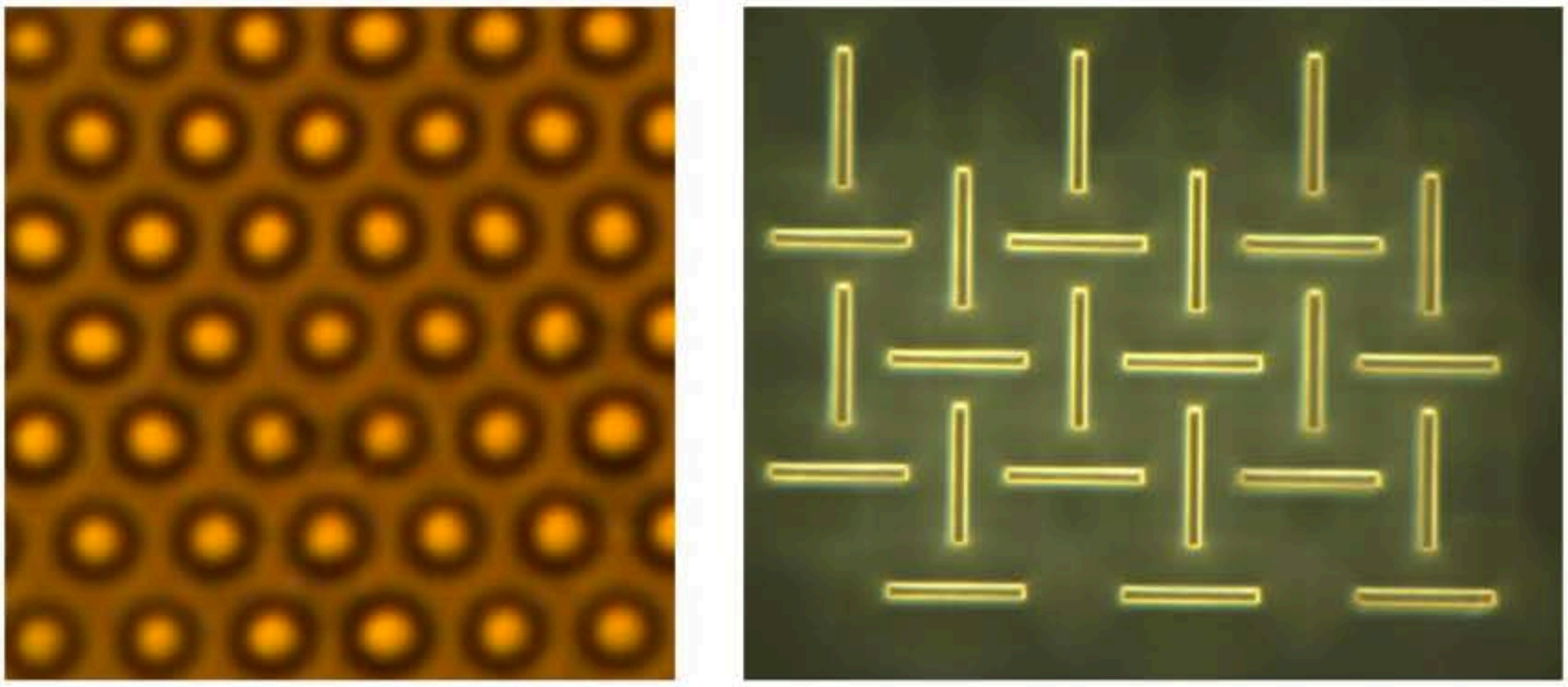

Figure 1: Examples of cylindrical waveguide structures created with UV photolithography with AZ40XT photoresist (left) and with free-standing rectangular waveguide structures in IP-resist using 2-photon NanoScribe 3-D printing (right).

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Fabrication and evaluation of microgel shapes as carriers for delivery of biomacromolecules

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Hydrogels are 3D polymeric matrices that imbibe water while maintaining their structural integrity when placed in aqueous environments. They have become increasingly important for drug delivery applications due to their biocompatibility, porous matrix and high water content, making them akin to biological cells and tissue. [1] The structural and physical properties of hydrogel matrices can be adapted allowing for the controlled release of biomacromolecules. Traditionally, hydrogel based micro- and nano- carriers have been fabricated by bottom-up techniques, yielding spherical carriers. However, recent studies highlight that carrier shape and size play a significant role in carrier flow, internalization and interaction with biological membranes. [2] As a result, there has been high impetus in developing shape and size specific carriers for drug delivery, bringing top-down techniques to the forefront for their development.

Recently, we have introduced UV-assisted punching as a novel technique for the top-down fabrication of microgel shapes with varying geometries. First, the geometry of the microgel shapes is defined in a Si master, fabricated by photolithography and reactive ion-etching (RIE). This master is then used to transfer the inverse geometry into a polymeric foil by hot embossing. The wells of the stamp are loaded with the hydrogel precursor by force assisted liquid distribution (FALD) on a roll-to-plate imprinter. Thereafter, the loaded stamp was assembled with a poly-vinyl alcohol (PVA) substrate and UV-assisted punching was performed to obtain individual microgel shapes (Fig.1A). In this process, the hydrogel precursor was crosslinked by UV radiation while the stamp was pressed into the PVA substrate, penetrating it to define individual microgel shapes.

Microgel shapes in circular, elliptical, square and rod-like geometries were successfully fabricated in sizes with carrier length varying from 100 µm to 8 µm (Fig.1A, B, C). Microgel shapes could be loaded with biomacromolecules as an integral part of the fabrication process (Fig.1D). *In vitro* release of the loaded biomacromolecule in release media at pH 7 was explored to demonstrate the potential of microgel shapes as carriers for the delivery of biomacromolecules (Fig.1E). Furthermore, hemolysis assay on the microgel shapes revealed no hemolysis indicating their biocompatibility (Fig.1F).

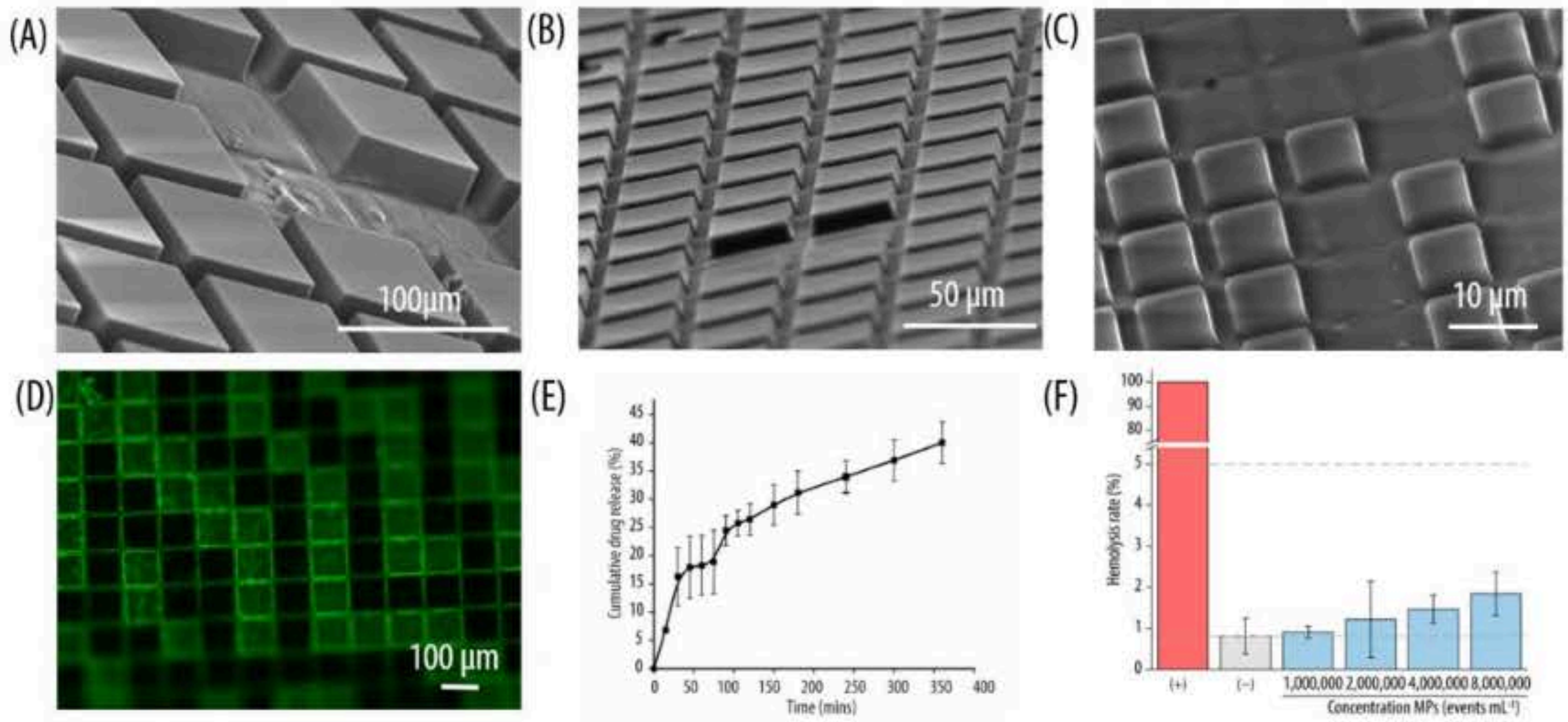

Figure 1: (a)-(c) SEM images of square microgel shapes on a PVA substrate fabricated by UV-assisted punching with dimensions - (a) 100X100X25µm, (b) 35X35X8.75µm and, (c) 8X8X2µm. (d) Fluorescent microscopy image of100X100X25µm microgel shapes loaded with BSA-FITC on the PVA substrate, (e) *in vitro* release of biomacromolecule loaded microgel shapes in release media at pH 7, (f) hemocompatibilty of the microgel shapes.

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A novel antibacterial coating based on functionalized chitosan

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Over the past decade, an increasing number of studies have provided insight into the intrinsic antimicrobial activity of chitosan (CTS), a natural cationic polysaccharide. Numerous attempts have been made to use CTS to inhibit the growth of pathogenic microorganisms on the PLA surface of medical devices or food packaging[1, 2]. However, due its poor solubility, high viscosity and ease of aggregation, CTS has limited affinity for the PLA surface, resulting in an unsatisfactory antibacterial effect. Additionally, the acidic solvents used to dissolve CTS are unsuitable for industrial production. Chemical functionalization of CTS allows for the desired polymer and coating properties to be achieved, as well as industrial production.

In this work, an ultrasonic atomization assisted LbL assembly technique was used to prepare a hydrophilic and antibacterial functionalized chitosan coating on a PLA surface due to the Shiff's base reaction within and between layers. In comparison to CTS coating, functionalized chitosan coating had better hydrophilicity and transparency, a more definite industrialization potential, and higher antibacterial activity at experimental concentrations (Figure 1).

The results demonstrated that the ultrasonic nebulization assisted LbL assembly functionalized chitosan coating is a promising alternative for improving the hydrophilicity and antibacterial activity of the PLA surface.

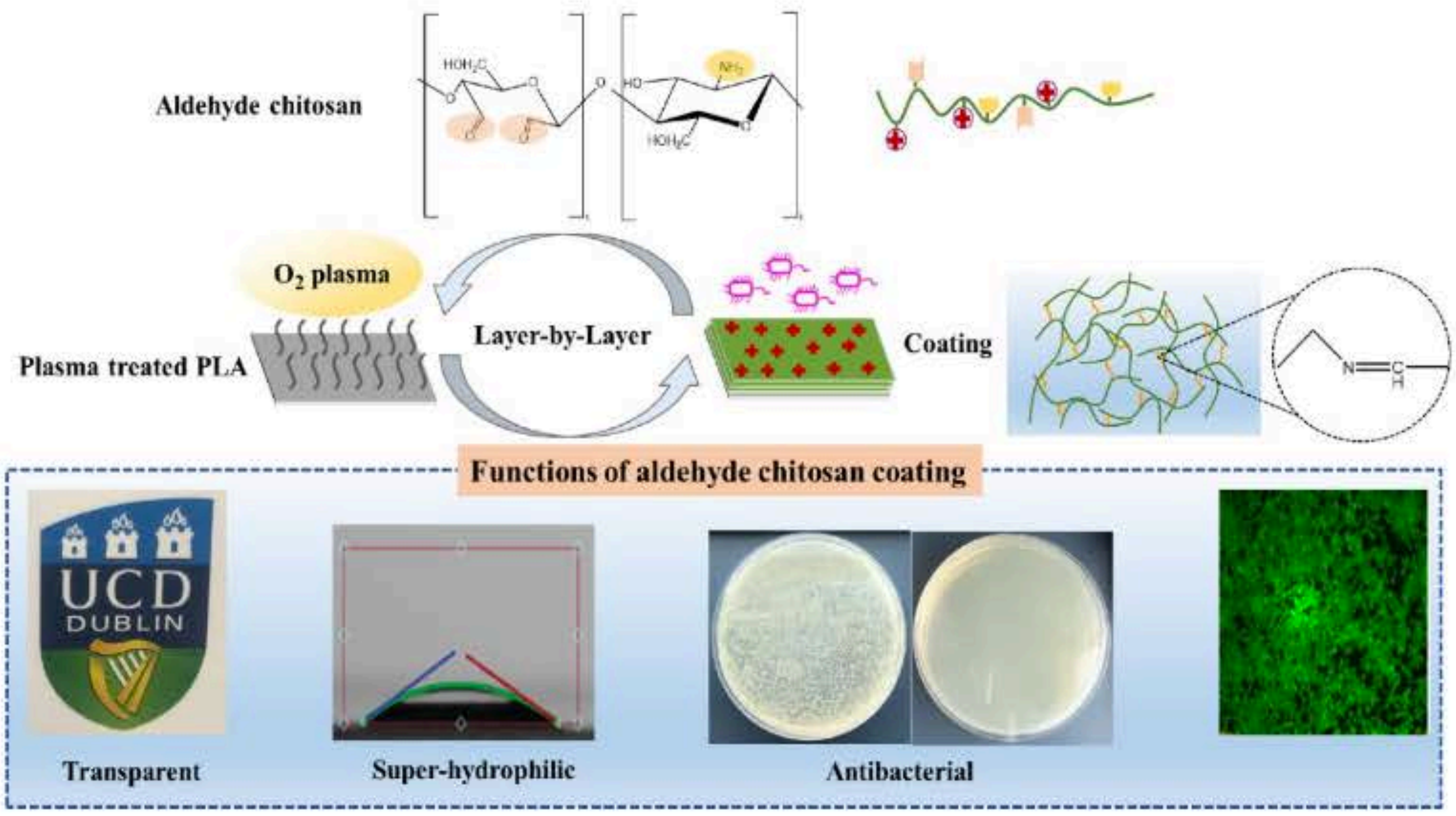

Figure 1: The fabrication and functions of aldehyde chitosan coating.

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Multifunctional strong-bonded 3-layered polymer coating on WE43 for drug-eluting stent applications

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Center of Micro/Nano Manufacturing Technology (MNMT-Dublin), School of Mechanical & Materials Engineering, University College Dublin, Belfield, Dublin 4, Ireland

Drug-eluting stents (DESs) are coated with antiproliferative drugs (e.g., paclitaxel and sirolimus), which are released from polymer carrier (mostly biodegradable) coatings on a metal substrate. Here the major problem is hydrogen gas formation on the surface of Mg during its degradation in the body environment which causes the polymer coating to peel off [1,2].

In this study, an oxide layer is used to increase the bonding strength between a Multifunctional 3-layered polymer coating (PCL-PLLA-PLGA) and WE43 as well as protect the WE43 against degradation [3]. The hydrophobic nature of polycaprolactone (PCL) acts as an anti-corrosion barrier as it prevents water uptake. Poly-L-lactic acid (PLLA) [4] acts as a bridge between the inner and outer layer and finally, FDA-approved biocompatible Poly Lactic-co-Glycolic Acid (PLGA) is used as a drug carrier Fig (1-a) [5].

The oxide layer was formed on the surface using the anodizing method in a 1 mol/l NaOH bath Fig (1-b,1-c). Potentiodynamic polarization and Electrochemical Impedance Spectroscopy results show that the Oxide layer itself can increase the corrosion resistance a lot (1-d,1-e). In addition, the oxide layer increased the roughness causing stronger adhesion for polymer coating. This oxide layer has a draw-back which is its hydrophilicity. This can be overcome by adding a thin Stearic Acid layer on the surface. The contact angle of the oxide layer increased from approximately 15° to above 100°.

In conclusion, this study is still in progress and in vitro analysis will be considered after finalizing each polymer coating on WE43 to achieve a good profile of properties based on coating thickness.

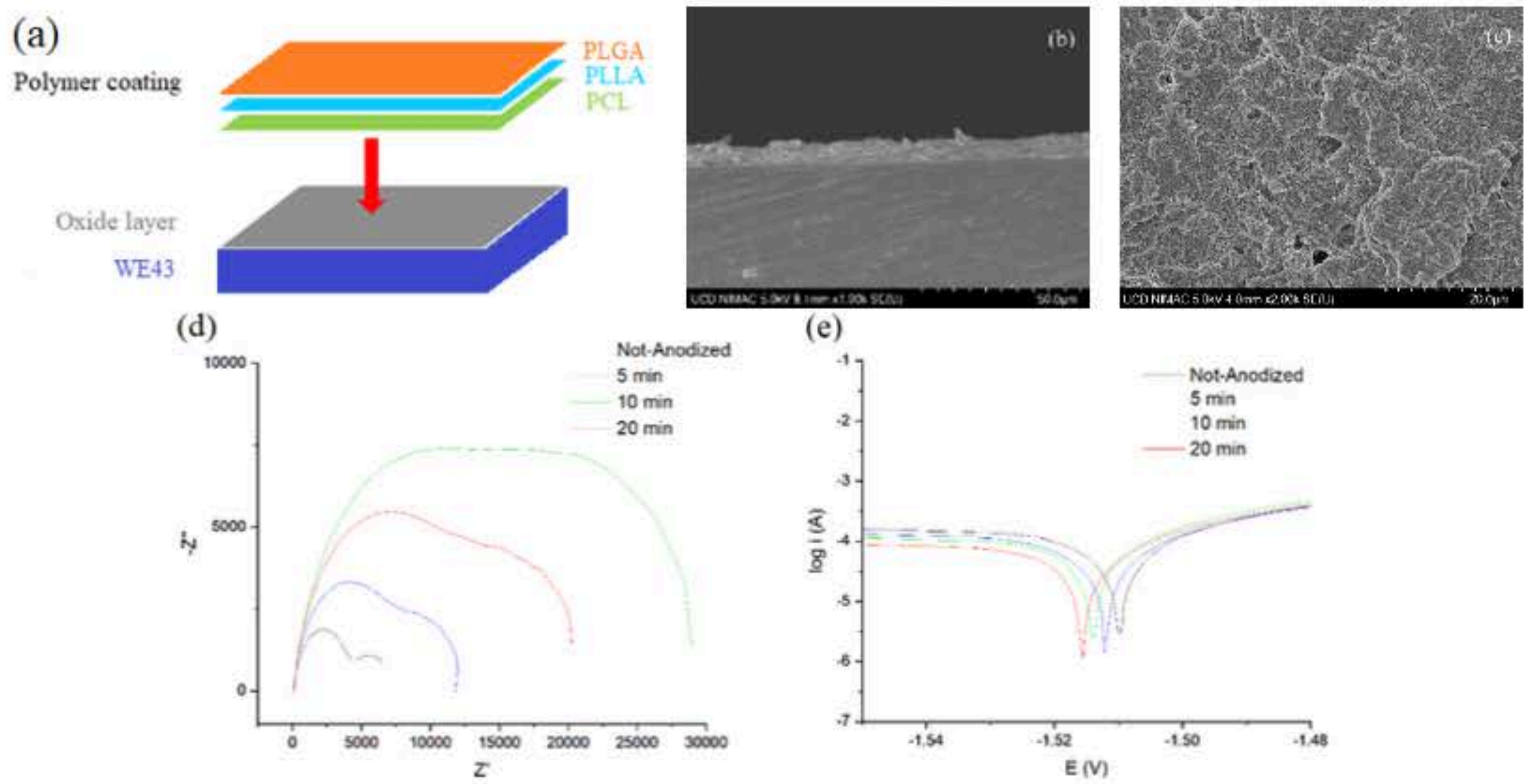

Figure 1: (a) Schematic of 3-layered polymer coating on WE43, (b) Cross-section image of oxide layer (c) Oxide layer microstructure (d) EIS and (e) PDP diagram.

Acknowledgement: This project is funded by the EU's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 956097.

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1. Hong S-J, Hong M-K. *Drug-eluting stents for the treatment of coronary artery disease*: A review of recent advances. Expert Opinion on Drug Delivery. 2022;19(3):269-280.
2. Dobatkin S, Martynenko N, Anisimova N, et al. Mechanical Properties, Biodegradation, and Biocompatibility of Ultrafine Grained Magnesium Alloy WE43. Materials. 2019;12(21).
3. Shi Y-j, Pei J, Zhang J, et al. Enhanced corrosion resistance and cytocompatibility of biodegradable Mg alloys by introduction of Mg(OH)2 particles into poly (L-lactic acid) coating. Scientific Reports. 2017;7(1).
4. Zhu Y, Sheng Y, Zheng L, et al. Poly(l-lactic acid) (PLLA) Coatings with Controllable Hierarchical Porous Structures on Magnesium Substrate: An Evaluation of Corrosion Behavior and Cytocompatibility. ACS Applied Bio Materials. 2019;2(9):3843-3853.
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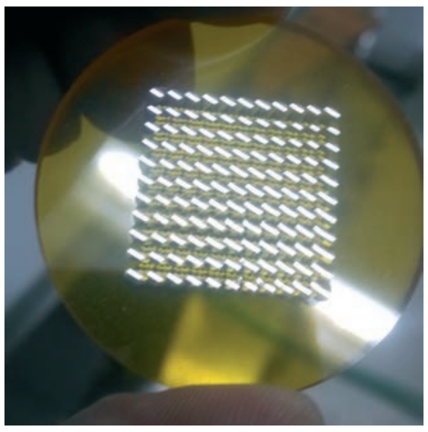
Centre of Micro/Nano Manufacturing Technology (MNMT-Dublin)

MNMT-Dublin Core Values

- *Integrity and respect*
- *Diligence in our work*
- *Stillness of mind*
- *Pursuit of perfection*



UCD Centre of Micro/Nano Manufacturing Technology (MNMT-Dublin) conducts the cutting-edge research in manufacturing led by Professor Fengzhou Fang who has over 30 years of experience in manufacturing science and technology. He was responsible for setting up the Centre of Micro/Nano Manufacturing Technology (MNMT) at Tianjin University in 2005. MNMT has been recognised as a leading manufacturing research centre worldwide, particularly in ultra-precision manufacturing and micro/nano manufacturing.

Prof Fang has managed a large number of national, international, and industry funded research projects. His research interests are in micro/nano manufacturing, optical freeform manufacturing, medical device/implant manufacturing, ultra-precision manufacturing and metrology. Some of the applications areas include medical devices, bio-medical implants, aspheric and freeform optical systems, aerospace and engineering components.

Professor Fang has worked with over a hundred of industrial partners assisting companies to develop their R&D activities. He has published over 200 papers in peer reviewed journals, along with 12 book chapters and holds over 50 patents. He is a Founding President of the International Society for Nanomanufacturing (ISNM), a Council Member of the International Academy for Production Engineering (CIRP), a Charted Engineer of UK Engineering Council, and the editor-in-chief of the Nanomanufacturing and Metrology (N&M). He is a Fellow of ISNM, Fellow of CIRP, and Fellow of the Society of Manufacturing Engineers (SME).

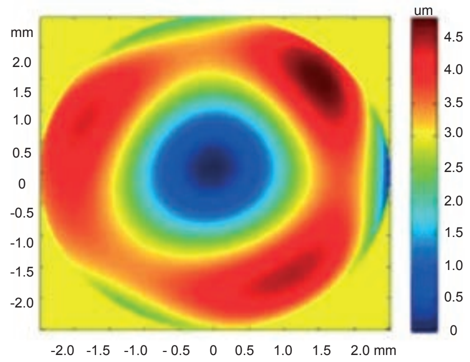
Professor Fang is a recipient of SME Albert M. Sargent Progress Award.

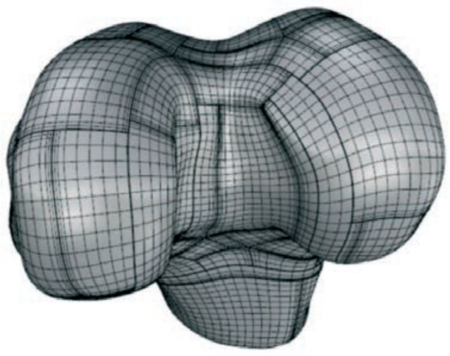
RESEARCH SCOPE

MNMT-Dublin carries out fundamental research and application development in advanced manufacturing

MNMT-Dublin research and development areas are as follows:

- **Micro/nano manufacturing**—micro/nano features fabrication, fundamentals study, new process development, process monitoring and automation, measurement and evaluation, devices and equipment.
- **Bio-medical device manufacturing**—medical device development, medical implants machining, implant intraocular lens and contact lens manufacturing and measurement.
- **Optical freeform manufacturing**—aspheric and freeform optical system design, machining and metrology.
- **Ultra-precision machining**—machining fundamentals, process and instruments development, monitoring and metrology.
- **Precision manufacturing**—machining process, monitoring and automation, measurement and evaluation.





Intraocular Lens and Implant of Next Generation

Application Brief

Microfluidic Electrical Impedance Spectroscopy. Measured.

Key Benefits

- Probe impedance simultaneously at 6 frequencies
- Resolve fast microfluidic process on a 5 µs timescale
- Measure over a wide range from 1 mHz to 50 MHz
- Reduce background noise with differential current input

Typical Results and Schematics

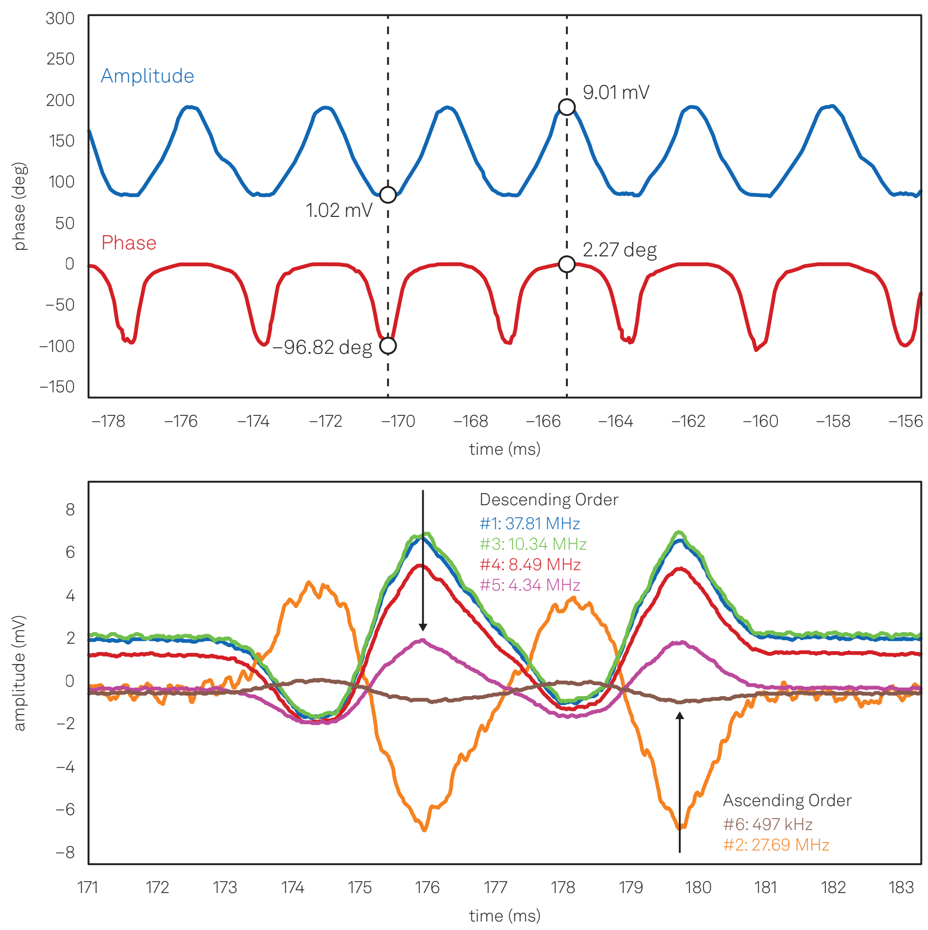


Figure 1. The current acquired with the HF2LI-based microfluidic measurement setup. Upper figure: single-frequency current and phase at 10 MHz. Lower figure: current acquired simultaneously at 6 frequencies. The transimpedance gain in both figures is set at 1 kV/A.

Measurement Strategies

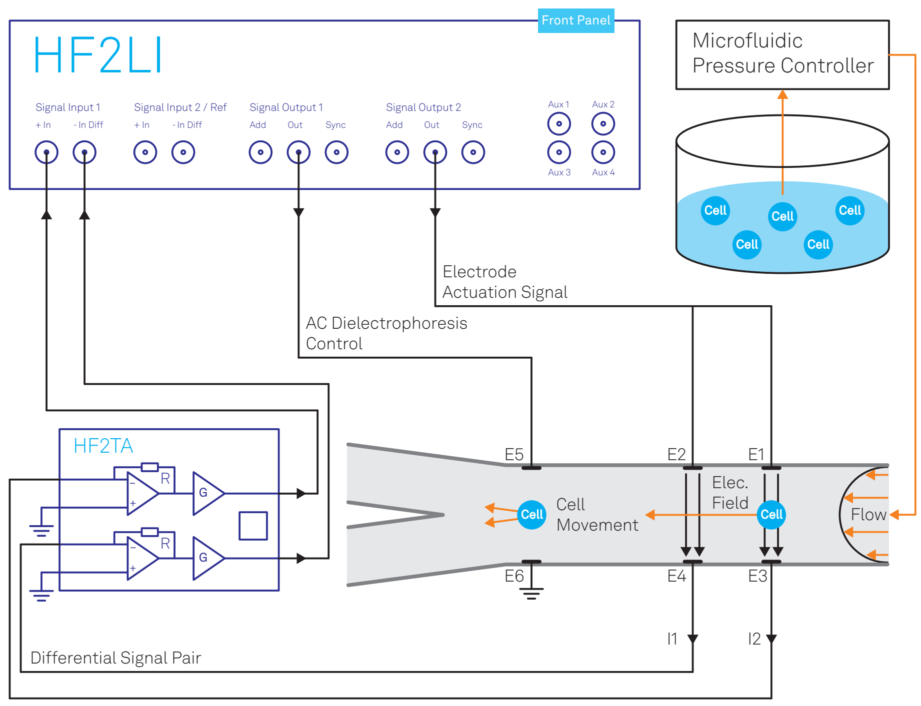


Figure 2. A typical measurement setup where the Zurich Instruments HF2LI and HF2TA measure the differential current from the passing analyte in a microfluidic channel.

Measuring particles or cells in a microfluidic flow requires a high sensitivity and a fast response. As the analyte enters and exits the differential electrode pairs in the microfluidic chip, a peak and a trough in current are observed (figure 1). With a differential input, the signal from the surrounding fluid is suppressed, meaning each cytometry event can be resolved with reduced noise.

The HF2LI Lock-in Amplifier plays a key role for electrical impedance spectroscopy measurements in a microfluidic setup (figure 2). With the LabOne Plotter or the data acquisition (DAQ) module, it is possible to record multi-frequency impedance data on a 5 µs timescale. Full impedance spectra can be acquired between 1 mHz and 50 MHz thanks to the LabOne Sweeper module.

Why choose the HF2LI?

- Simplified setup by combining detection and sorting together on the same instrument
- Included LabOne® software for data acquisition and processing
- Automated workflow thanks to 5 APIs (Matlab®, LabView®, .NET, C, Python)
- Used independently or as part of a turn-key system

Zurich Instruments
Technoparkstrasse 1
CH-8005 Zurich
Switzerland
www.zhinst.com
info@zhinst.com
+41 44 515 04 10

HF2LI
50 MHz Lock-in Amplifier

Zurich Instruments

2 Input Channels, 2 Signal Outputs
High dynamic reserve, low noise

Product Leaflet
Release date: January 2019

Key Features

- DC – 50 MHz, 210 MSa/s, 14 bit
- 5 nV/√Hz input noise, 120 dB dynamic reserve, 1 µs minimum time constant
- 6 demodulators, up to 6 oscillators
- LabOne® Toolset: Scope, Parametric Sweeper, Imaging Module, FFT Spectrum Analyzer
- APIs for LabVIEW®, .NET, MATLAB®, C and Python

Summary

The Zurich Instruments HF2LI is a high-frequency dual channel lock-in amplifier that uses the latest hardware and software technologies to provide industry leading specification and functionality. The dynamic reserve of 120 dB sets the benchmark in the 50 MHz frequency range. In many setups a single HF2LI replaces multiple conventional instruments.

The basic instrument functionality can be extended with the following upgrade options:

- HF2LI-MF Multi-frequency
- HF2LI-PID Quad PID Controller
- HF2LI-PLL Dual Phase-locked Loop
- HF2LI-MOD AM/FM Modulation

These options are upgradable in the field. For current measurements we offer the HF2TA Current Amplifier as an active probe that can be placed close to the setup, e.g. for 4-probe measurements.

Description

Signal Inputs and Outputs

The two 14 bit signal inputs exhibit a minimum noise of 5 nV/√Hz. The 210 MSa/s sampling rate ensures sufficient aliasing suppression and high SNR. Linear combinations of up to 6 sinusoids can be output at a resolution of 16 bit in multiple ranges up to ±10 V. The amplitude, frequency, and the phase shift of each component can be controlled with the HF2LI-MF Multi-frequency option installed.

Demodulators and Filters

All filter properties of the 6 dual-phase demodulators can be individually configured, including the time constants (1 µs to 500 s) or bandwidths (80 µHz to 200 kHz) and filter orders (1st to 8th). The digital filters offer a much higher dynamic reserve, zero drift, precise phase shifts, and perfect orthogonality in contrast to their analog counterparts.

LabOne is Instrument Control

The HF2LI includes the LabOne control software. Thanks to the latest web server technology, the user interface can be easily accessed from any browser. With LabOne the computer is the cockpit for instrument control, data capture, analysis and storage where every setting is no more than 2 clicks away. The functionality includes an Oscilloscope, a Spectrum Analyzer, an Imaging Module, a Plotter and a Parametric Sweeper for quick and easy measurement automation and much more.

Choice of APIs

For convenient integration into existing control environments, programming interfaces for LabVIEW, .NET, MATLAB, C and Python are provided.

Expert in polymer micro/nano manufacturing

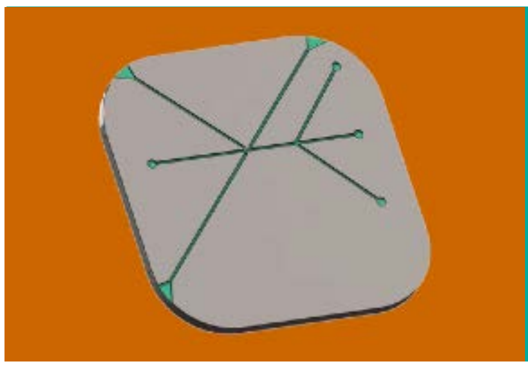
MiNAN Technologies focuses on bridging the gap between laboratory research and mass production by assisting you to design, develop and fabricate precision plastic microfluidic chips

We provide customisation services and products:

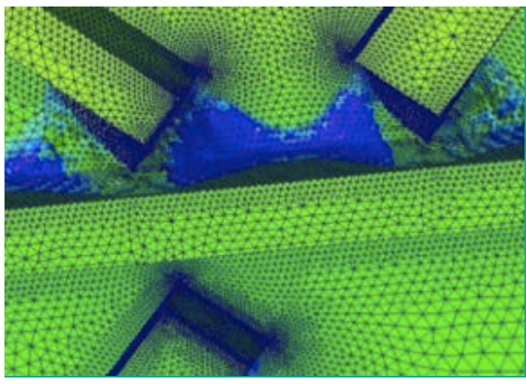
- Design, material selection and process development
- Micro/nano structured tooling by precision micro/nano electroforming and micro machining
- High precision replication using micro injection moulding and micro hot embossing
- Precision chip bonding using UV-assisted bonding and thermal diffusion bonding
- Injection mould development
- Small or large quantities for cost-effective production and customer validation

Applications:

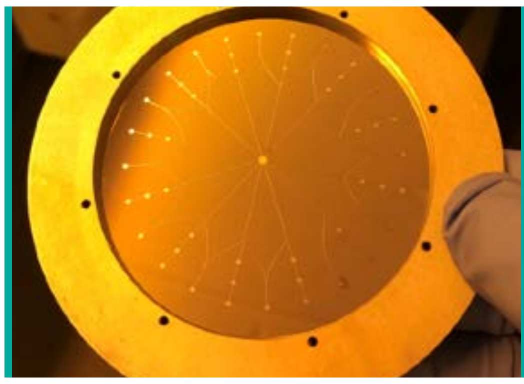
- Point of care testing
- Drug development etc.



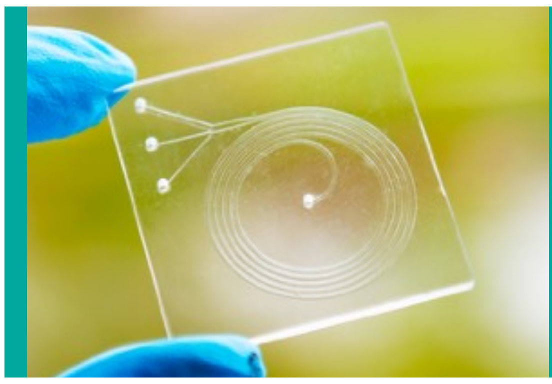
Design



Simulation



Tooling



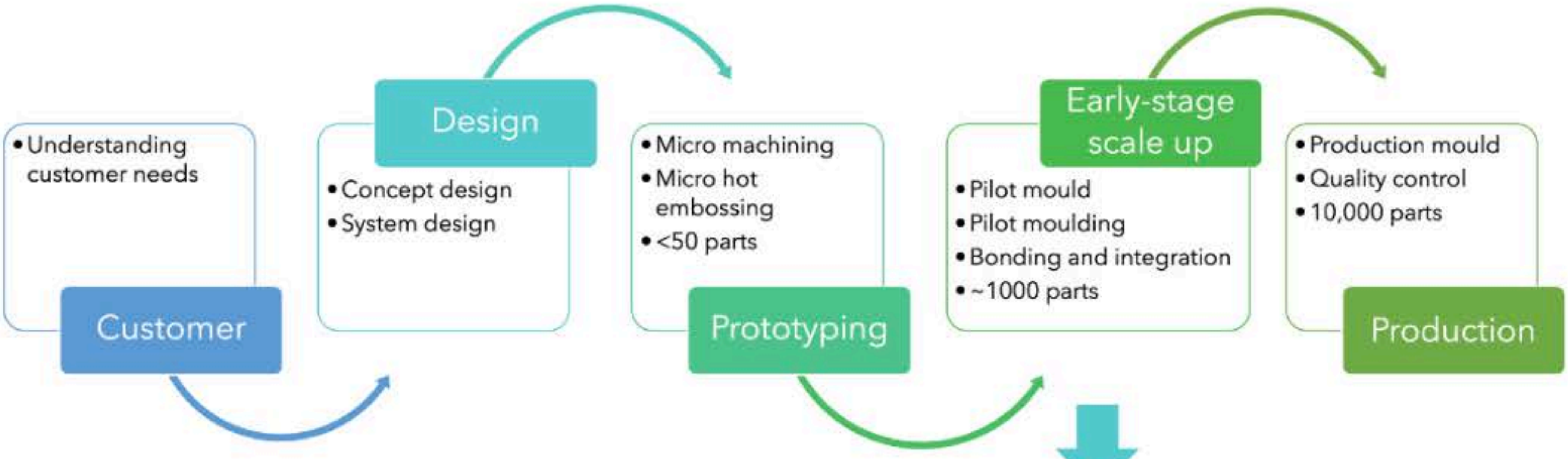
Replication & Assembly

MiNAN Technologies

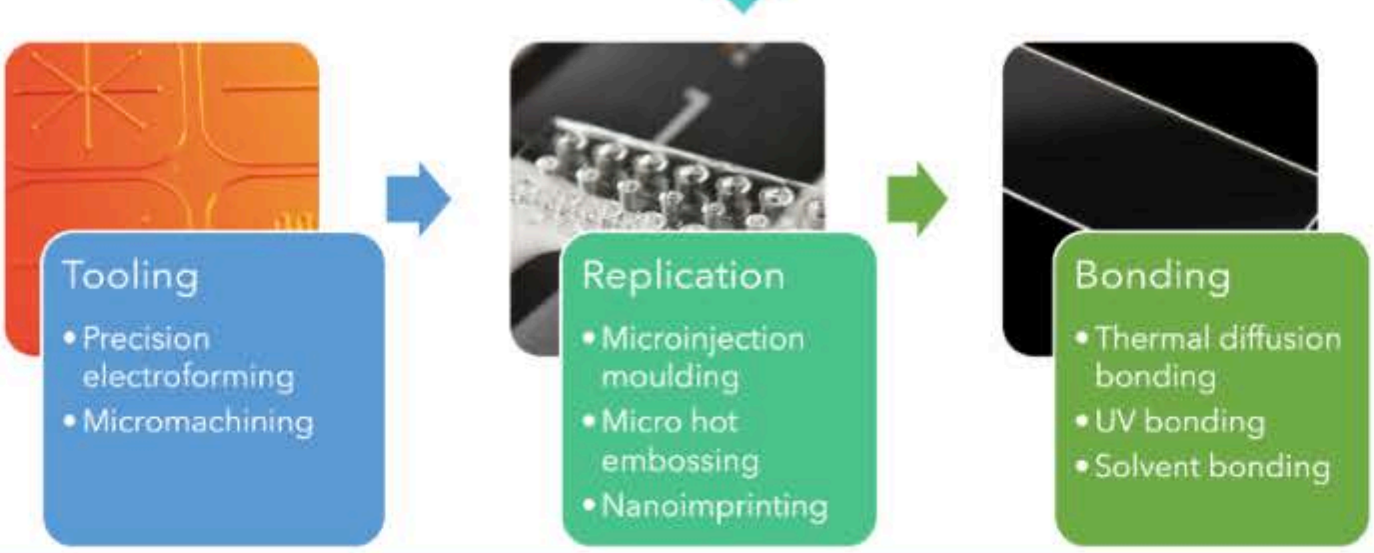
NovaUCD , Belfield, Dublin 4, Ireland

Tel: +353-1-7161989
Email: info@minan-tech.com

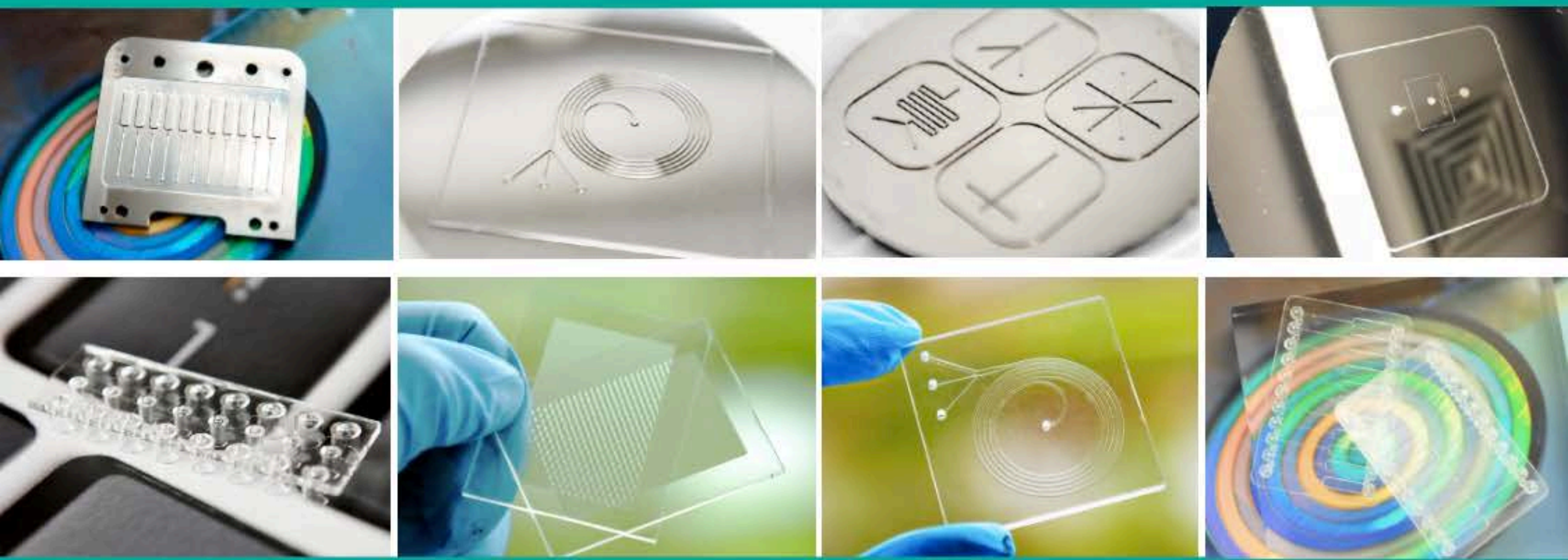
Process chain to engage and serve customers



We start to work with our clients at the early stages of a project. We offer both production and engineering services, including material selection, product design, mould design and construction, prototyping, process development, mass production, and back-end services.



Case Studies



How to work with us?

Contract
Contract R&D as required

Research
We are interested in fundamental research collaboration for potential projects

Funding Application
We are keen to collaborate on national and international applications for research funding

Consulting
We can offer consultancy services on your design and help with prototyping and early-stage scale-up

PROGRAM

09-10 May 2022: Online or Room 206, UCD Material Science and Engineering Center for in-person

PRN 2022 Polymer Replication on Nanoscale

Monday 9 May 2022

09:00-10:00 (GMT) Individual pre-conference meetings

10:00-10:10 **Kenneth Stanton (Head of UCD School of Mechanical and Materials Engineering, Ireland)**
Welcome address

10:10-10:20 **Nan Zhang (MNMT-UCD, Ireland)**
Welcome to the Polymer Replication on Nanoscale 2022

Session 1: Mastering and Tooling (10:20-12:55)
Chair: Michael Gilchrist (UCD, Ireland)

10:20-10:55 **Nan Zhang (UCD, Ireland)**
Manufacturing of plastic microfluidics: Translating microfluidic devices from laboratory prototyping into scale-up production

10:55-11:30 **Invited: Gert-Willem Römer (University of Twente, the Netherlands)**
Laser texturing using (ultra) short pulsed lasers: Fundamentals and applications

11:30-12:05 **Invited: Graham Cross (TCD, Ireland)**
New nanometric technologies for diamond-like-carbon (DLC) injection mould inserts

12:05-12:30 **Yang Zhang (DTU, Denmark)**
Surface micro structuring injection moulding using soft tooling

12:30-12:55 **Tianyu Guan (UCD, Ireland)**
Synthesis of two-dimensional WS_2/nickel nanocomposites via electroforming for high-performance micro/nano mould tools

12:55-13:15 **Virtual Networking, coffee break (Online, Breakout room)**

13:15-13:50 Lunch break (individually)

13:50-14:00 Lab tour (video version)

Session 2: Microfluidics and functional surfaces I (14:00-17:00)
Chair: Nan Zhang (UCD, Ireland)

14:00-14:35 **Invited: Henne van Heeren (Enabling MNT, the Netherlands)**
Trends in the microfluidic industry 2022

14:35-15:00 **Rafael Taboryski (DTU, Denmark)**
Engineering of wetting properties for polymer surfaces

15:00-15:25 **Meng Li (Zurich Instruments, Switzerland)**
Fast electrical impedance spectroscopy for microfluidic single cell characterization and counting

15:25-15:35 Coffee break

15:35-16:00 **Damien King (FPC-DCU, Ireland)**
Injection moulded microfluidic lab on a disc platform for extracellular vesicle analysis

16:00-16:25 **Rohit Mishra (DCU, Ireland)**
POC Microfluidic Platform Technologies: Bridging the Translational gap

16:25-17:00 **Invited: Jed Harrison (FPC-DCU, Ireland)**
Micron and Nano-scale Polymer Systems for Biochemical Analysis

17:00-17:20 **Virtual Networking, coffee break (Online, Breakout room)**

Join PRN2022 Zoom Meeting

https://ucd-ie.zoom.us/j/64571382027?pwd=RllrU0NKeGRRUlhMWUtBazFEN1Njdz09

Meeting ID: 645 7138 2027

Passcode: 056427

Tuesday 10 May 2022

Session 3: Micro/nano Replication (09:00-11:00)
Chair: Damien King (DCU, Ireland)

09:00-09:35 **Invited: Per Magnus Kristiansen (FHNW, Switzerland)**
Polymer surface topographies go industrial

09:35-10:10 **Invited: Giovanni Lucchetta (Unipd, Italy)**
Modeling the replication of submicron-structured surfaces by micro injection moulding

10:10-10:35 **Nastasia Okulova (In-mold, Denmark)**
Roll-to-roll Extrusion Coating – expanding the boundaries of roll-to-roll replication in thermoplastic materials

10:35-11:00 **Sana Zaki (UCD, Ireland)**
Shaping of mould tools manufactured by UV LIGA and 3D printing

11:00-11:20 **Virtual Networking, coffee break (Online, Breakout room)**

Session 4: Microfluidics and functional surfaces II (11:20-12:55)
Chair: Per Magnus Kristiansen (INKA FHNW, Switzerland)

11:20-11:55 **Invited: Ruth Schmid (SINTEF, Norway)**
Nanomedicine today and tomorrow

11:55-12:30 **Invited: Eoin O'Cearbhaill (UCD, Ireland)**
3D printing of medical devices designed towards optimal soft tissue interaction

12:30-12:55 **Yuyang Zhou (Soochow University, China)**
Scalable mass manufacturing process for micro/nanostructure engineered plastic films with viral and microbial resistance

12:55-13:15 **Virtual Networking, coffee break (Online, Breakout room)**

13:15-14:00 Lunch break (individually)

Session 5: Advanced materials for micro/nano structuring (14:00-16:20)
Chair: Hengji Cong (UCD, Ireland)

14:00-14:35 **Invited: Wenxin Wang (UCD, Ireland)**
Biopolymer-based tough hydrogels for additive manufacturing

14:35-15:00 **Brian Vohnsen (UCD, Ireland)**
From wavefront sensors to retinal implants with polymers

15:00-15:25 **Shahana Bishnoi (DTU, Denmark)**
Fabrication and evaluation of microgel shapes as carriers for delivery of biomacromolecules

15:25-15:50 **Xiaoyu Wang (UCD, Ireland)**
A novel hydrophilic and antibacterial coating based on functionalized chitosan

15:50-16:15 **Seyed Masih Mousavizadeh (UCD, Ireland)**
Multifunctional strong-bonded 3-layered polymer coating on WE43 for drug-eluting stent applications

16:15-16:20 Voting for the Best Presentation Awards for Early-Stage Researchers (Online)

16:20-16:40 **Virtual Networking, coffee break (Online, Breakout room)**

16:40-16:50 Announcement of Best Presentation Awards and closing by Nan Zhang

16:50-17:30 Networking, Beer/Refreshments

Close of PRN 2022 and announcement of PRN 2023