TOPICALITIES

Edited by Markéta Držková

CONTENTS

News & more

A yearly update on recently completed EU-funded projects

The selected projects that were supported under Horizon 2020 programmes and are based on or related to printing and media are introduced in more detail in the following sections. A few more examples are briefly mentioned here. The project Graphene 3D received funding for research and innovation staff exchange to facilitate the development of multifunctional graphene-based nanocomposites with robust electromagnetic and thermal properties intended for the 3D printing of multifunctional cellular structures for electronics. The innovation in the ceramics industry making use of dedicated inkjet printing machines was supported within the European Training Networks funding scheme in the scope of the DOC-3D-PRINTING project. Several projects dealt with biomedicine, such as the two supporting business innovations: Bone3Dmatch, developing patient-specific biomimetic materials for bone regeneration, and InnovationOrigin, assessing products based on cultivated medical-grade marine coral as biomaterials for 3D printing in health care. Another direction is represented by the ERC project D3, which developed methods for the automatic interpretation of drawings to create 3D models.

CapTherPV – Integration of capacitor, thermoelectric and photovoltaic thin films for efficient energy conversion and storage

The outcomes of this seven-year project that received the ERC Consolidator Grant include, among others, new transparent photothermal devices, organic solar cells integrated with transparent capacitors on both rigid and flexible substrates, and graphene-based capacitors applied directly to solar cells. The research work is described in more than 30 master theses and articles.

APOLO – Smart designed full printed flexible robust efficient organic halide perovskite solar cells

The publications resulting from this research and innovation action mostly deal with materials and design improvements of perovskite solar cells; one paper presents the interlaboratory study on the stability of carbon-based perovskite solar cells prepared by screen printing and provides insight into the suitability of different methods used for stability assessment.

SHERO – Self-healing soft robotics

The soft robotics demonstrators developed in the scope of this research and innovation action include, for example, the robotic gripper that could heal and resume its original tasks after being damaged under controlled conditions. The research described in about 50 papers involved the synthesis and characterisation of different types of reversible polymer networks and combining several processing techniques.

FUTURE-PRINT – Tuneable 2D nanosheet networks for printed electronics

The research within this long-term project that was funded by the ERC Advanced Grant is presented in 30 articles, which, besides the development

The European network in the field of flexible and wearable electronics

The EU-wide SmartEEs Association builds on the two innovation actions of the same name, which received funding from the Horizon 2020 programme for industrial leadership (SmartEEs for the period of 2017–2020 and SmartEEs2 for 2020–2023).

The projects supported selected European companies, from small enterprises to mid-cap ones, in their innovation efforts, which enabled testing of the implementation of flexible and wearable electronics technologies in various areas. The proposed applications include smart textiles in the vehicle interiors to improve thermal perception and comfort, a backpack illuminated with organic light-emitting diodes to provide additional safety and increase attractiveness of the sustainable activities it is intended for, a reusable, real-time monitoring device ensuring traceability of blood bags and the maintenance of adequate cold-chain conditions, a sensor composed solely of organic optoelectronics and measuring human pulse and arterial blood oxygenation, a small-scale datalogger integrated into boots, and an energy autonomous and flexible temperature logger using organic photovoltaic technology as an energy-harvester power source, to name a few.

The services to association members include the offer of courses on different levels and in various areas of interest, full access to a virtual marketplace, which provides information on technical solutions and helps business development, as well as other resources, such as white papers and reports, the organisation of different kinds of events to facilitate networking, and the support in finding funding, public or private.

New Intergraf publications

The 2023 edition of the annual Intergraf Economic Report presents statistical information for the 27 member countries of the European Union, complemented by the data for the United Kingdom, Norway, Switzerland and Iceland. The official consolidated statistics from Eurostat cover the years up to 2020, 2021 or 2022, depending on their type. The key indicators for the European printing industry show that the number of companies and employees remained rather stable during the last years with approx. 2 % decline, but the turnover decreased by more than 10 %. Packaging and labels represented 55 % of the production value, while periodicals and books were 9 % each. Among EU27, Poland, followed by Italy, Netherlands and Germany, are the main net exporters of printed products, whereas the top net importer is France. The import of printed products from China almost doubled when comparing 2020 and 2022, where books and colouring books make up 63 %. Within the historical review, interesting insight is provided by comparing the 2022 electricity prices to 2020 and 2008. Traditionally, the report includes the European print market review and forecast by Smithers.

This spring, Intergraf with FEP, the Federation of European Publishers, and Cepi, the Confederation of European Paper Industries, published a joint statement entitled 'Books as a driver of Europe's knowledge economy'. Building on the PISA report 21st-Century Readers: Developing Literacy Skills in a Digital World (OECD, 2021), the EC Digital Economy and Society Index (DESI) 2020, the COST E-READ Stavanger Declaration Concerning the Future of Reading (2019) and the European Paper Recycling Council Monitoring Report 2021, it claims that books build culture, printed books promote fairness across the digital divide and are a healthy alternative to screen time, the best tools for long-form reading, sustainable and essential for Europe's economy as well as to the development of communities.

and characterisation of nanosheet networks, describe their use in all-printed thin-film transistors and dielectric capacitors, discuss the effect of the gate volume on the performance of printed transistors based on nanosheet networks, and more.

3D2DPrint – 3D Printing of novel 2D nanomaterials: adding advanced 2D functionalities to revolutionary tailored 3D manufacturing

Among over 30 articles resulting from this long-term project that received the ERC Consolidator Grant, the most recent deal, for example, with functionalising single-walled carbon nanotubes in printed supercapacitor devices, confining silicon microparticles with nanoporous structure in the carbon nanotube segregated network, which enables the fabrication of high-performance electrodes, the mechanism of the oxygen reduction reaction in $BaMnO_3$ and the source of inherent instability in electrocatalysts for the oxygen evolution reaction based on NiFe layered double hydroxides.

DROP-IT – Drop-on demand flexible optoelectronics & photovoltaics by means of lead-free halide perovskites

Three of about 20 articles resulting from this research and innovation action describe heterojunction diodes for photodetection applications, halide perovskite light-emitting diodes on rigid and flexible substrates and high-quality emissive nanocrystalline perovskite layers for colour conversion and light-emitting diodes applications, all printed by inkjet. Others mainly deal with studies on perovskite materials, including their crystallographic data.

MADRAS – Advanced materials and processing in organic electronics

The technology developed during this innovation action, which includes nanocellulose-based substrates, conductive and semiconducting inks and in-mould electronic devices, was implemented into two different demonstrators: the geotracking smart tag comprising a flexible self-adhesive label with a rigid electronic unit and the fingerprint reader with a biometric sensor.

LEE-BED – Innovation test bed for development and production of nanomaterials for lightweight embedded electronics

The test bed developed within this innovation action offers consulting services concerning the technical, economic, pre-safety, hazard and life-cycle assessment, standardisation, intellectual property rights and patenting, funding and investment capital search on the one hand, together with pilot lines for developing and scaling-up nanomaterials and formulations, printing and assembling of components, characterising print and selecting the appropriate printing technology for production on the other hand.

EMoBookTrade – The early modern book trade: an evidence-based reconstruction of the economic and juridical framework of the European book market

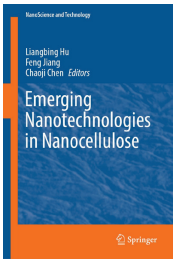
This research, funded by the ERC Advanced Grant, used unexplored evidence revealing connections between book history and economic history. The data were processed and collected in two online research databases, one containing about 33 000 book prices derived from 73 sources from major European firms in 10 different currencies, and the other 5 300 Venetian book privileges. The findings were shared during conferences, seminars and workshops and published in several books, book chapters and articles.

Bookshelf

Emerging Nanotechnologies in Nanocellulose

This book from the NanoScience and Technology series was written to provide a comprehensive overview of design principles, fundamental knowledge and up-to-date research in the field of nanocellulose and the related emerging nanotechnologies. The present attention paid to this material reflects the environmental concerns as well as the substantial advances in nanotechnologies. The potential application areas of high-performance materials based on cellulose include optics, electronics, energy, environment and health. The printing technologies are used mainly for producing batteries or other energy-storage devices and in various biomedical applications.

The content comprises twelve chapters. The first introduces cellulose nanomaterials, methods of their production and characterisation and the current technical and economic challenges. The second is focused on the top-down processing of nanocellulose materials. It describes their intrinsic structure and fabrication strategies, different forms from 3D porous foam or dense bulk structure to 2D film up to 1D fibre. The applications of top-down nanocellulose materials also are mentioned, including electronics. The third chapter presents the recent development of multifunctional nanocomposites based on bacterial nanocellulose, the corresponding design principles and recent applications. The fourth one is dedicated to nanocellulose aerogels, namely the methods for constructing and controlling their structures, properties and functions and the applications of these materials. The fifth presents the design principles of strong and tough materials based on nanocellulose, their superb mechanical performance and modelling approaches explaining the multi-scale mechanics, while the sixth one focuses on light management of nanocellulose films and the corresponding design principles, theories and current strategies, including structural colour, as well as potential applications in optoelectronics and smart photonics. Chapter 7 discusses the advantages and limitations of nanocellulose paper as a flexible electronic substrate and describes the electrodes and flexible electronic devices, including the electromechanical transducer, energy storage device, solar cell, thin film transistor, organic light-emitting diode and touch screen. Two chapters deal with energy storage and nanocellulose-based printed power sources, printing techniques, preparation and characterisation of inks and printed devices – supercapacitors, lithium-ion batteries and others. Chapter 10 presents the application of nanocellulose for water treatment, namely its use in membranes or filters, adsorbents/absorbents and solar conversion devices for water generation. Chapter 11 is focused on mechanical energy harvesting and engineering nanocellulose thin films to develop triboelectric nanogenerators, e.g., a flexible and compact film with nanoscale surface roughness for harvesting energy from footsteps. Finally, the last chapter deals with biomedical applications of nanocellulose, the synthesis of different types of nanocellulose for functional biomaterials and the example applications, including 3D/4D printed scaffolds and hydrogels.

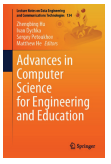


Editors: Liangbing Hu, Feng Jiang, Chaoji Chen

Publisher: Springer
1st ed., November 2022
ISBN: 978-3-031-14042-6
432 pages, 179 images
Hardcover
Available also as an eBook

Advances in Computer Science for Engineering and Education

Editors: Zhengbing Hu, Ivan Dychka, Sergey Petoukhov, Matthew He



Publisher: Springer
1st ed., April 2022
ISBN: 978-3031048111
554 pages, 233 images
Softcover
Also as an eBook

This volume presents a selection of 46 papers from the Fifth International Conference on Computer Science, Engineering, and Education Applications, ICCSEEA 2022, held in Kyiv, Ukraine. The wide range of topics includes, among others, modelling and simulating modulated ink flows in a short printing system of parallel structure and modelling of tone reproduction with round raster elements in the same system, mulsemedia, i.e. multiple sensorial media, namely the mulsemedia data processing language based on the algebraic system of aggregates (ASAMPL 2.0), which is designed to facilitate the development of mulsemedia applications, and the study of effects of students' interaction patterns on cognitive processes in blended learning.

Human-Computer Interaction Technological Innovation

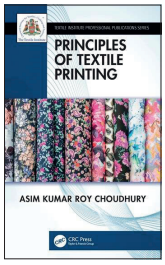
Editor: Masaaki Kurosu

Publisher: Springer
1st ed., May 2022
ISBN: 978-3031054082
700 pages, 359 images
Softcover
Also as an eBook

The 24th International Conference on Human-Computer Interaction, HCII 2022, which took place virtualy, comprised 21 thematic areas and affiliated conferences. This book, with 47 papers focused on technological innovation, is a part of the three-volume set, which includes the refereed proceedings of the thematic area that gave the conference its name, i.e. the human–computer interaction. The contributions

Principles of Textile Printing

Complementing the author's previous books on different aspects of textile chemistry, this one deals with the topic of textile printing from a technical perspective. The book aims to be of interest to all textile printers, from large printing houses to small ones. It begins with a history of textile colouration by dyeing and printing, providing the fundamental background on the preparation of materials and the printing devices, methods and styles. Then, the pre-processing of both natural and synthetic textile materials is presented, such as scouring and different types of bleaching. The following chapter is dedicated to dyes and auxiliary agents for thickening, wetting, oxidation and reduction, swelling, etc. The text presents the classification of colourants according to their chemical constitution and the application method. Also, it discusses the colour-fastness properties, toxicity and environmental aspects. The remaining five chapters deal with printing. First, an overview of various types of textile printing is presented. One chapter details direct printing with pigmented inks, reactive dyes, vat dyes, acid dyes and other dye types; it also briefly covers the discharge and resist printing styles. Then, one chapter is dedicated to manual printing methods, and the following describes the roller and screen printing machines. The last chapter deals with digital printing, including its comparison with screen printing. It outlines the basic concepts and principles, describes inkjet printers and inks, and discusses specific aspects of digital printing. Finally, it mentions 3D printing on textiles and innovative applications for technical textiles.



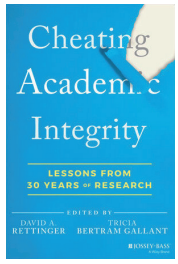
Author: Asim K. R. Choudhury

Publisher: CRC Press
1st ed., August 2022
ISBN: 978-1-138-47874-9
374 pages
Hardcover
Available also as an eBook

Cheating Academic Integrity Lessons from 30 Years of Research

Nine chapters of this book deal with the important topic of academic integrity, the reasons and ways of cheating by students, the role of the faculty and staff, and the methods helping to prevent or at least recognise academic cheating and plagiarism. The key point is communicated already in the first chapter, arguing that the last 30 years of research have shown that cheating is evitable – it can be mitigated and minimised. Two chapters provide an overview of trends in plagiarism and cheating prevalence from the 1990s to the present and a closer look at contract cheating. It seems that the trend

Editors: David A. Rettinger, Tricia Bertram Gallant

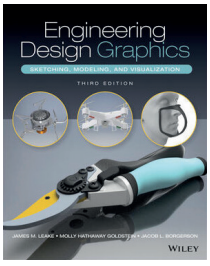


Publisher: Jossey-Bass
1st ed., March 2022
ISBN: 978-1-119-86817-0
256 pages
Softcover
Available also as an eBook

is positive, probably thanks to the efforts put in increased awareness and improved skills; however, the disruption due to COVID-19 and the recent enormous development of technologies can lead to an opposite shift. The same factors are substantial also in the case of contract cheating. Then, the book offers a psychological perspective on the causes of cheating, including practical suggestions on enhancing academic integrity, as well as insights into the perception of cheating and the consequent decisions to cheat or not. The following text stresses the importance of implementing high-impact pedagogical practices, which also applies to online teaching. The last two chapters review the most influential pieces from 30 years of research on academic integrity and provide an outlook for the next 30 years.

Engineering Design Graphics
Sketching, Modeling, and Visualization

This popular textbook was first published in 2008. The current edition was revised to reflect the development since the second one from 2012, such as the trends toward cloud-based solutions, freeform modelling, 3D printing and scanning, generative design, and also human-centred design. The text covers the steps of the engineering design process, design thinking and communicating, hand drawing, 2D and 3D graphics terms, formats and software, different views and projections, including isometric drawing, design for additive manufacturing, file formats of 3D printers, and more. The accompanying website provides the image gallery and solutions manual for each chapter; in addition, videos are available for the two chapters dealing with planar and perspective projections.



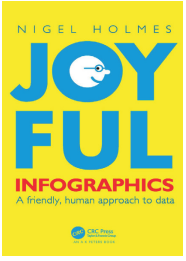
Authors: James M. Leake, Molly Hathaway Goldstein, Jacob L. Borgerson

Publisher: Wiley
3rd ed., March 2022
ISBN: 978-1-119-68842-6
464 pages
Softcover
Available also as an eBook

Joyful Infographics
A Friendly, Human Approach to Data

Thanks to the author's experience, this new book on infographics brings what its title promises. Nigel Holmes shares his influences, a personal timeline of infographic landmarks, approaches to make graphics joyful, as well as examples illustrating what to avoid. Further, he deals with icons, presentations, comprehensible scientific infographics and illustrated charts.

Author: Nigel Holmes



Publisher: CRC Press
1st ed., December 2022
ISBN: 978-1-03-211965-6
215 pages, 259 images
Hardcover
Available also as an eBook

present, for example, the method for high-speed thermochromism control, which integrates water cooling circuits and electric heating circuits printed with conductive silver nanoparticle ink, or the paper-based numeric keyboard using ArUco markers, intended as a low-cost disposable keyboard for VR systems and mobile devices. The focus of the other two parts is on the theoretical approaches and design methods and the user experience and behaviour, respectively.

Advances in Design, Music and Arts II

Editors: Daniel Raposo, João Neves, Ricardo Silva, Luísa Correia Castilho, Rui Dias

Publisher: Springer
1st ed., June 2022
ISBN: 978-3031096587
909 pages, 352 images
Hardcover
Also as an eBook

This book comprises the proceedings of the 8th International Meeting of Research in Music, Arts and Design, EIMAD 2022, held in Castelo Branco, Portugal. Almost 60 contributions are organised into five parts, including the first one presenting 14 papers on Communication Design, Design Education and Thinking.

Bauhaus Effects in Art, Architecture, and Design

Editors: Kathleen James-Chakraborty, Sabine T. Kriebel

Publisher: Routledge
1st ed., April 2022
ISBN: 978-1032205397
212 pages, 63 images
Hardcover
Also as an eBook

This part of the Routledge Research in Art History series focuses on the impact of the Bauhaus in a wide range of fields, including the relationship with New Typography and its effects on graphic design discussed in the second chapter.

Flexible OLEDs
Fundamental and Novel Practical Technologies

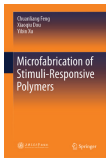
Author: Mitsuhiro Koden

Publisher: Springer
1st ed., July 2022
ISBN: 978-9811935435
112 pages, 128 images
Softcover
Also as an eBook

This concise book published in the SpringerBriefs in Applied Sciences and Technology series provides the basics and history of flexible organic light-emitting diodes and an overview of suitable substrates, gas barrier technologies, encapsulation and novel electrode technologies. The last chapter describes diodes with on-demand patterns by ink-jet printing.

Microfabrication of Stimuli-Responsive Polymers

Authors: Chuanliang Feng, Xiaoqiu Dou, Yibin Xu



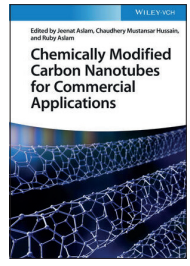
Publisher: Springer
1st ed., March 2021
ISBN: 978-9813368682
197 pages, 124 images
Hardcover
Also as an eBook

This book focuses on interfacial reactions, the immobilisation of (bio)molecules and the fabrication of biomolecular patterns by reactive microcontact printing. In nine chapters, it covers reactive platforms for controllable fabrication of functional interfaces, surface reactions of organic and polymeric films and the methods for their patterning, confinement effects on the reactivity in ultrathin polymer films, platforms for the immobilisation of biomolecules, tailored biointerfaces via derivatisation of polystyrene-*b*-poly(*tert*-butyl acrylate) thin films, reactive microcontact printing, submicron molecular patterning, nanofabrication on reactive block copolymer film platforms, and bioinspired hierarchically structured polymer interfaces for promising biomedical applications.

Chemically Modified Carbon Nanotubes for Commercial Applications

The aim of this book was to summarise the recent advancements in the chemical modification of carbon nanotubes, facilitating their use in various applications on a commercial scale. The first part provides the background on the properties, synthesis, characterisation and surface modification of carbon nanotubes, together with an overview of their commercialisation and the related economic aspects. The remaining five parts deal with applications of chemically modified carbon nanotubes, presenting current approaches, case studies and future perspectives; four parts cover the areas of energy and environment, electronics and related devices, biomedicine and construction, and the fifth one is dedicated to the emerging applications. In particular, individual chapters describe the use in energy production and storage, adsorption of pollutants, removal of textiles effluents, membrane separation, water purification, electronics and photonics, electrochemical sensors, lab-on-chip devices, cancer therapy, drug delivery, tissue engineering, cement-based materials, 3D and 4D printing with the example applications including liquid sensors and stretchable supercapacitors, tribology applications for controlling friction and wear properties, and corrosion protection. The last chapter discusses the commercial-scale developments for the fabrication of chemically modified carbon nanotubes, covering several methods of both covalent and non-covalent functionalisation.

Editors: Jeenat Aslam, Chaudhery M. Hussain, Ruby Aslam

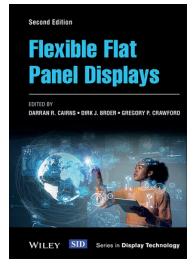


Publisher: Wiley-VCH
1st ed., February 2023
ISBN: 978-3-527-35072-8
544 pages
Hardcover
Available also as an eBook

Flexible Flat Panel Displays

The original edition of this book was published in 2005. This revised edition brings a completely restructured content that was contributed by 45 experts active in the field worldwide and reflects the substantial progress achieved, especially in the areas of foldable organic light-emitting diode displays and flexible liquid-crystal displays, as well as the state-of-the-art solutions to technical challenges. The chapters deal with liquid crystal optical coatings, metallic nanowires, optically clear adhesives, self-healing polymer and flexible glass substrates, encapsulation, organic field-effect transistors, reflective display, electronic paper, flexible batteries, x-ray detectors, roll-to-roll production challenges, direct ink writing, and more.

Editors: Darran R. Cairns, Dirk J. Broer, Gregory P. Crawford



Publisher: Wiley
2nd ed., February 2023
ISBN: 978-1-118-75111-4
416 pages
Hardcover
Available also as an eBook

Bookshelf

Academic dissertations

Component Fabrication by Printing Methods for Optics and Electronics Applications

Doctoral thesis – Summary

Author:
Pauliina Vilmi

Speciality field:
Electrical Engineering

Supervisor:
Tapio Fabritius

Defended:
26 February 2021, University of Oulu, Faculty of Information Technology and Electrical Engineering Oulu, Finland

Contact:
pauliina.vilmi@gmail.com

Further reading:
ISBN: 978-952-62-2854-9

The research within this thesis explored the capabilities of printing as a beneficial fabrication method for three types of components: the high-quality, low-cost microlens array, the fully printed functional memristor, and the double-sided capacitive sensor element. The main focus was on the design and fabrication processes. Inkjet printing was used for microlenses and memristors, whereas for the sensor, it was screen printing. These two methods complement each other in terms of the resolution and size of printed features while both enabling roll-to-roll processing. In addition, the functionality of the fabricated components in specific applications was also verified. Thanks to the chosen printing techniques and components applicable in different fields, the work demonstrates the versatility of printed intelligence.

The dissertation reviews the relevant characteristics of inkjet and screen printing technologies, the inks, substrates and methods used for the fabrication of components, as well as the methods used for their characterisation, which included profilometry, optical and scanning electron microscopy and measurements of current–voltage characteristics and capacitance. Then it presents and discusses the results achieved for individual components. For microlenses, a transparent UV-curable photoresist was inkjet-printed on flexible polyethylene terephthalate and rigid glass substrates pre-patterned by the photolithography. Based on the direct microscopy imaging results, the imaging quality of the microlens array printed on glass is comparable to that of the commercial glass reference and outperforms the hot-embossed lenses. For the memristive structure, all materials, i.e. silver nanoparticle ink, TiO_x and photoresist, were printed by inkjet. Its characterisation confirmed the device's functionality and revealed the limitations due to the ununiform thickness of the active layer and the short lifetime. Capacitive sensors were screen-printed with a silver paste onto a high-efficient particulate air filter to detect its dirtiness level and successfully integrated into a vacuum cleaner.

Influence of the Nanocomposite Coating Composition on the Cardboard Packaging Characteristics

Doctoral thesis – Summary

Author:
Tomislav Hudika

Speciality field:
Graphic Technology

Supervisor:
Tomislav Cigula

Defended:
8 July 2022, University of Zagreb, Faculty of Graphic Arts Zagreb, Croatia

Contact:
thudika@grf.hr

This thesis investigated the possibility of improving the protective function of printed packaging through special coating. The approach is based on adding nanoparticles into commercial varnish so that its application will reduce the degradation of the packaging material caused by electromagnetic radiation, improve its barrier properties and, with the assistance of UV radiation, also antimicrobial properties while not significantly changing its colorimetric characteristics.

The first chapter of the dissertation presents the results of preliminary research on consumers' attitudes towards packaging. The responses of over 150 survey participants indicated the impact of its properties on the perceived quality of goods, especially due to colour degradation and mechanical damage of the packaging. In addition, about a third of respondents would value protection from potentially dangerous microbes. The text then defines the

objectives and provides the background on the packaging industry, materials, branding and design, paperboard, printing and coatings. The theoretical part also presents the basic characteristics of nanoparticles used for coating modification, namely zinc oxide, titanium dioxide and silicon dioxide. The study included four types of modified coatings; nanocomposites were formulated with ZnO, TiO_2, ZnO/SiO_2 and TiO_2/SiO_2. Two chapters explain the structure of the experiment, specify materials, i.e. woodfree coated paperboard, offset process inks based on vegetable oil, water-based varnish and the three types of nanoparticles, describe sample preparation, which comprised printing by offset lithography, preparation and application of nanocomposite coating with 0.25–1 % of nanoparticles by flexography and subsequently the accelerated ageing, and provide details on characterisation methods. Another two chapters present and compare the results achieved. For individual process colours, the modification with nanoparticles induced the change up to approx. 2.5 ΔE^*_{ab} when compared to the coating with commercial varnish. Mostly, the coatings with TiO_2 provided higher protection against accelerated ageing and water vapour. Regarding antimicrobial properties, the best results were obtained for the coatings with ZnO in the case of aerobic mesophilic bacteria contamination and *Listeria monocytogenes* growth after artificial inoculation.

Further reading:
http://eprints.grf.unizg.hr/id/eprint/3359

Doctoral thesis – Summary

Author:
Ahmed Raouf Fahmy

Speciality field:
Food Technology

Supervisor:
Thomas Becker

Defended:
26 April 2023, Technical University of Munich, TUM School of Life Sciences Munich, Germany

Contact:
ahmedraouf.fahmy@uni-hohenheim.de

3D Printing and Texture Modulation of Cereal-Based Matrices

This thesis advanced the existing knowledge in the area of 3D-printed starch-based materials and their tailoring in different aspects. To accomplish the aims concerning the relationship between texture and taste and creating the appropriate textures, the work comprised the development of methods for assessing printing quality and material structure to elucidate its behaviour, the sensory design of food textures, their thermal stabilisation, and texture modulation with respect to hardness and deformation.

The first part of the dissertation provides a concise overview of the relevant concepts from 3D printing of food material systems, available printing techniques, material and process parameters, their effects on printing behaviour and quality with its assessment, to modulation of cellular starch-based foams using 3D printing, describing the formation and stabilisation of the porous structure, the relation between structure and texture, mechanical behaviour of starch-based foams important for handling and mastication, up to reviewing state of the art in 3D printing and fabrication of starch-based textures. Further, it deals with the methods for post-processing and thermal stabilisation after 3D printing. Finally, it presents the thesis objectives defined on this basis along with the approach and methods used for the characterisation of raw materials, 3D printing, image processing, finite element modelling and simulations, rheological measurement and texture profile analysis. The main part presents the four studies and discusses the overall outcomes. The first study investigated the printability of gluten-containing and gluten-free starch-based material systems at various hydration levels and proposed the in-line camera-based method to characterise the morphology and the resulting behaviour and quality. The second was focused on sensory design in food 3D printing. In particular, it dealt with precise structuring, texture modulation, taste localisation by the inhomogeneous spatial distribution of sodium chloride, and thermal stabilisation using an in-line NIR heating system. The last two studies investigated texture modulation in and beyond the elastic regime, developing and verifying the design formula relating hardness to the chosen Young's modulus, porosity and geometry and analysing the large-deformation stress–strain profiles, the strain rate and viscoelastic response to extend the textural modulation in the non-linear regime.

Further reading:
https://nbn-resolving.de/urn/resolver.pl?urn:nbn:de:bvb:91-diss-20230426-1687067-1-9

Events

NANOTEXNOLOGY 2023

Thessaloniki, Greece
1–8 July 2023

Traditionally, this large international event combines multiple conferences presenting the advances in the fields of nanosciences and nanotechnologies (NN23), flexible organic electronics (ISFOE23), digital and additive manufacturing and 3D (bio)printing (I3D23), accompanied by the related summer schools (ISSON23) and exhibition, as well as the three-day business forum and matchmaking event. The first conference is already in its 20th edition. The speakers invited for this year's plenary session are Magnus Berggren presenting 'Thiophene-based trimers for evolvable and in-vivo-manufactured electrodes and electronics', Peer Fischer on 'Nanostructures in motion: chemical motors and nanorobotic systems' and David King with the lecture 'The climate crisis: the state of climate science, and what must be done now'. Overall, the rich programme features almost a hundred keynotes and invited talks by experts representing research organisations from across the globe, numerous conference papers and also over 50 posters in the dedicated ISSON23 session. The ISSON participants interested in organic electronics can learn about the design of nanoscale structures in optimising organic solar cells, design and synthetic aspects of organic and polymer materials, hybrid interfaces between nanosensors and living cells, brain-inspired next-generation optoelectronics, advanced characterisation and simulation of photovoltaics and organic light-emitting diodes performance, microelectronics, intelligent nanomanufacturing and in-line metrology for quality control, and more.

FLEPS 2023
5th IEEE International Conference on Flexible, Printable Sensors and Systems

Boston, Massachusetts, USA
9–12 July 2023

In 2023, this event offers five tutorials on the first day; their topics cover scalable and self-healing hybrid electronic materials, bioinspired in-sensor computing, flexible and stretchable inorganic solar cells, materials, design, manufacturing, functionalities and applications of e-tattoos, and fabrication strategies for wearable and implantable biochemical sensors. The conference technical programme is scheduled for three days, each opened by a plenary lecture. The announced topics are 'Flexible electronics: challenges and opportunities – a materials science view' by Natalie Stingelin, 'Electrophoretic display technology for ultra-low power smart and green switching surfaces' by Edzer Huitema, and 'Soft bioelectronics: design concepts for engineered elasticity' by Stephanie Lacour. Also, the programme offers 20 invited lectures and seven focused sessions that reflect selected emerging areas not covered by regular tracks. To facilitate networking between the academic community and industry in the field, the programme includes talks by six industry experts in a dedicated session and lab tours.

FuturePrint 2023

São Paulo, Brazil
12–15 July 2023

After the two years impacted by the pandemic, the 2022 edition of this Latin American fair, a successor of the Serigrafia SIGN FutureTEXTIL show, attracted over 40 000 visitors. This year's edition again offers a wide range of brands and products for screen printing, digital printing, 3D printing, cutting and recording, finishing and other accessories, as well as software solutions, for the sectors of sign and signage, textile digital printing, packaging, promotional materials, and digital signage.

XVIII Color Conference

Lecco, Italy
15–16 September 2023

The speakers invited to the current edition of this established event are the light artist Christopher Bauder, Raimondo Schettini on colour in data visualisation, and Andrew Stockman, presenting cone fundamentals and the research towards predicting the colour matching functions of individual observers, e.g. those with colour-vision deficiency.

CIE 2023
30th Quadrennial Session of the CIE

Ljubljana, Slovenia
15–23 September 2023

Besides the CIE division and technical meetings, this event includes the conference themed 'Innovative Lighting Technologies' (18–20 September) and offers five workshops on photometry, lighting design and education.

SGI Dubai 2023
Sign & Graphic Imaging Middle East

Dubai, UAE
18–20 September 2023

This exhibition for the Middle East and Africa, now in its 26th edition, covers a wide range of both proven and innovative solutions and materials for applications in the printing, signage, graphic and imaging industries.

C!print

Madrid, Spain
19–21 September 2023

The Madrid edition of this show offers, among others, the Plug&Play workshop to demonstrate the current options for the customisation and personalisation of products, including a dedicated online application.

Pack Print International 2023

Bangkok, Thailand
20–23 September 2023

The 9th International Packaging and Printing Exhibition for Asia highlights the current trends – sustainability, artificial intelligence, safety and security, digital economy, premium design and 3D printing.

Digital Textile Congress 2023

Ghent, Belgium
28–29 September 2023

The lectures scheduled for this year deal with process parameters determining the resulting quality and, thus, the optimal applications, different types of inks and their properties, new solutions to increase sustainability, the use of extended reality, and more.

FLEX 2023

San Francisco, California, USA
11–13 July 2023

This event for flexible hybrid and printed electronics, held with the SEMICON West show, is this year also co-located with the 60th DAC – Design Automation Conference. The Flex keynote speakers are Richard Price, emphasising the importance of simplification when developing flexible integrated circuits, Michelle Foss, highlighting the need for flexibility also in materials supply chains, and Kris Erickson, discussing the advances in additively manufactured electronics.

SIGGRAPH 2023
The 50th International Conference & Exhibition on Computer Graphics & Interactive Techniques

Los Angeles, California, USA
6–10 August 2023

The extensive programme of this year's edition celebrates 50 years of the SIGGRAPH event, offering five days of conference sessions, a three-day exhibition, and more. It can be joined in person or online.

SPIE Optics & Photonics 2023

San Diego, California, USA
20–24 August 2023

Again, the contributions of this large multidisciplinary event include those presenting various advances related to printing. Several papers deal with 3D printing of lighting components and systems, such as 3D-printed refractive secondary optics for light-emitting diodes or advanced luminaire using 3D-printed electronics, and components printed by inkjet, e.g. metal-halide perovskite large-area optoelectronic devices, large-area dichroic mirrors and ternary logic circuits based on carbon nanotube homojunctions. Others present the in-situ reactive inkjet synthesis of ZnO nanostructures, dry transfer printing of nanomaterials for advanced wearable displays, photobleaching of transparent photopolymer resins, integrating printed organic electronics with plant tissues for environmental monitoring, etc., or further topics, e.g. the segmentation of Ottoman and early Turkish Republic printed documents and advanced correlation filters for printed character recognition.

49th iarigai and 54th International Circle Conferences

Wuppertal, Germany
18–20 September 2023

The annual conferences of the International Association of Research Organizations for the Information, Media and Graphic Arts Industries and the International Circle of Educational Institutes of Graphic-Media Technology and Management are again held as joint event. The scientific programme is complemented by the ESMA Networking Day on 20 September.