

TOPICALITIES

Edited by Markéta Držková

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News & more

Recent patents in multimaterial printing

This year's overview of recent patents focuses on those granted since the beginning of 2021 and retrieved for the term "multimaterial printing". The search returned more than five hundred patents available in English, dominated by the Chinese and U.S. patents, each comprising about 40 %. The remaining fifth includes the patents granted by the European (8 %), Japanese and Korean (4 % each) patent offices, along with a few others. Overall, the inventions relate to a variety of fields and applications, although the diversity is somewhat lower than in the case of printed electronics, see this section in JPMTR Vol. 10, No. 1 (2021). The assignees with more than one patent from the current selection comprise about 40 %; however, only over a dozen of them have five or more patents granted recently. The following sections are limited to those with the most documents related to the concept in focus. They represent both academia and industry, from small companies with a few employees to global corporations.

Massachusetts Institute of Technology

The MIT research into 3D and 4D printing, see this section in JPMTR Vol. 9, No. 2 (2020) and Bookshelf in JPMTR Vol. 10, No. 3 (2021), is reflected also in patent documents. The recent ones include EP 3 622 050 B1 Cell-mimetic device, fabricated by projection microstereolithography and comprising an array of fibres including those with diameters below 10 μm and elastic moduli tunable within the MPa to Pa range, US 11,179,878 B2 Methods and apparatus for parametric fabrication, capable to produce objects with a controlled variation of material composition and properties at different locations, and US 11,260,586 B2 Multimaterial 3d-printing with functional fiber, where the intended structure is produced from continuous fibre that consists of at least three different materials, combining electrical conductors with a functional component and encapsulating material. Other examples are US 10,953,605 B2 Additive manufacturing in gel-supported environment (jointly with Steelcase), presenting the approach that is considerably faster and eliminates the need for support structures while allowing to print large parts with complex geometries, US 11,009,020 B2 Vacuum pumps and methods of manufacturing the same (with Edwards Vacuum), employing polyjet printing, US 11,155,025 B2 Methods for additive manufacturing of an object (with Stratasys), describing the production of 3D-printed objects with predicted transformation in response to an external stimulus, and more.

Zhejiang University

The numerous patents granted worldwide to this university, one of the oldest in China, include several Chinese patents in the area of 3D and 4D printing. To provide a few examples, CN 110 171 127 B 3D printing system describes a solution for multi-material alternate feeding and non-uniform mixing; also, it presents a printable biomaterial with suitable mechanical and gel-forming properties. A device described in CN 110 228 193 B Integrated colored light 3D biological printing system based on imaging principle utilises volume imaging for photocuring of different materials at different parts. Another design with multiple spray head assemblies is applied in CN 110 450 405 B

Winners of the 2022 Flexographic Technical Association awards



Recipients were announced during the Awards Banquet at FTA's FORUM in March.

The 2022 FTA Technical Innovation Award has two winners – DuPont Cyrel Solutions for the Cyrel Lightning Plates optimised for UV-LED exposure and the Czech company SOMA for its SOMA Changeover Wizard, a user interface of new SOMA Optima flexo presses. The latter technology not only optimises and automates the tasks during the job changeover but also guides the press operator through the whole process, which is seen as even more valuable when considering the current workforce situation. Among the recipients of the FTA Sustainability Excellence Award, the company Industrias de Plasticos (Inplasa) based in Honduras was recognised for its social responsibility. The comprehensive sustainability programme of this Latin American company manufacturing flexible packaging and having more than 300 employees has five main pillars: the photovoltaic plant that provides power for the whole facility, recycling of polyethylene, polypropylene and solvent, and also wood pallets recycling that enabled, among others, to manufacture dozens of desks donated to support the local educational centres. The second winner, the U.S. company Footprint, is focused on the design, development and manufacturing of plant-based fibre solutions. It received the award for the innovations in sustainability, namely for its shelf-stable cup from moulded fibre printed using indirect flexography. The unique printing press employs conical technology to reduce distortion and improve colour densities when printing on the tapered cup. The recipients of the Excellence in Flexography Awards and the FTA President's Award were announced as well, together with the new member of the FTA Hall of Fame.

New paper-based, fire-resistant shipping wrap for batteries

The U.S. company
PACT, Packaging
And Crating



Technologies, has recently developed a new technology to ensure the transport safety of flammable items, especially lithium-ion batteries. The solution called Thermo Shield is based on planar and pleated layers of kraft paper coated with fire-suppressive ink, which releases water molecules when heated and thus cools the internal environment of the container. The company claims that this light-weight, fully recyclable corrugated packaging can suppress thermal runaway and propagation at temperatures up to 800 °C, and restrict the temperature outside the wrap itself to 60 °C, also suppressing the release of fumes or gasses and limiting the external oxygen supply. In this way, the wrap prevents damage to the outside shipping container and protects the surrounding environment.

Interoperability Conformance Specifications (ICS) for colour management based on the ICC.2 specification

These documents provide workflow-specific requirements and restrictions to iccMAX as defined in ISO 20677-1:2019 Image technology colour management – Extensions to architecture, profile format and data structure. In 2021, the International Color Consortium approved a core set of ICS documents as a guide for building iccMAX profiles for given use cases, checking the validity of iccMAX profiles, and selecting profile subclasses and profiles for a particular workflow. The set includes the colorimetric ICS for conversions to and from a custom Profile Connection Space (PCS) in the general domain, the spectral reflectance ICS for ColorSpace or Input Device profiles with conversions between multispectral data and a spectral reflectance PCS, the extended output ICS for printing and output colour reproduction, and the extended dynamic range ICS for displays and images.

Multi-nozzle cooperative biological printing method. Besides these solutions towards bioprinted tissues or organs, the recent Zhejiang University patents include CN 113 601 836 B Robot-assisted large-scale fiber-reinforced heterogeneous multi-material in-situ additive manufacturing system, intended to produce a continuous multi-material composite structure combining more resin materials with selected, typically carbon fibre.

Huazhong University of Science and Technology

This Chinese university is also active in 3D and 4D printing, as shown by its recent patents, such as US 11,110,663 B2 Polymer multi-material high-flexibility laser additive manufacturing system and method thereof, where different filaments are extruded in a sequence and fusing takes place outside the extrusion unit, CN 110 936 605 B Biological 3D printing device suitable for gradient structure multi-material, which employs multiple spray heads, or those presenting printed parts, e.g. CN 110 957 133 B Bionic deformable capacitor based on 4D printing and CN 110 962 161 B Phase deformation execution device based on 4D printing (both jointly with Jilin University).

Inkbit

This company, founded in 2017 as a spin-off from MIT Computer Science and Artificial Intelligence Laboratory, develops a multi-material jetting platform assisted by machine vision. Its recent patents include e.g. US 10,926,473 B1 Multi-material scanning for additive fabrication, US 11,173,667 B2 Precision system for additive fabrication, and US 11,186,033 B1 Material interlocking.

Stratasys

Besides the joint patent with MIT mentioned above, the recent patents of this established company include, for example, EP 2 664 443 B1 Solid free-form fabrication using a plurality of modeling materials, US 11,179,879 B2 Three-dimensional printing combining ring-opening metathesis polymerization and free radical polymerization, and US 11,235,511 B2 Three-dimensional inkjet printing of a thermally stable object.

Desktop Metal

The recent patents of this company, founded in 2015 and focusing on metal and carbon fibre 3D printing, include US 10,974,299 B2 Additive fabrication using variable build material feed rates, US 11,014,163 B2 Calibration of 3D printer via computer vision, and others.

Sakuu

Founded in 2016 as KeraCel, Sakuu develops solid-state printed batteries. Its patents include, among others, KR 10-2316641 B1 Electrophotographic multi-material 3D printer and US 11,224,917 B1 Multi-material three-dimensional printer with underlying adjustable binder.

Align Technology

This company innovates orthodontic and restorative treatment since 1997. Its recent patents cover different aspects, as illustrated by US 11,096,763 B2 Automatic treatment planning, US 11,106,135 B2 3D printed composites from a single resin by patterned light exposures, and US 11,189,021 B2 Machine based three-dimensional (3D) object defect detection.

Bookshelf

Additive Manufacturing

This volume on additive manufacturing technologies and appropriate finishing operations was contributed by almost 60 authors from across the globe. It is the third one from a four-volume series of Handbooks in Advanced Manufacturing, which is intended to give an account of the progress in various manufacturing technologies and provide their understanding by presenting the relevant fundamental research, latest developments and case studies. The first two volumes cover machining, finishing, welding and deformation; the fourth deals with the sustainable manufacturing processes.

The presented handbook is organised into three sections. Nine chapters deal with the technologies for additive manufacturing. The first one introduces the general concept of additive manufacturing, the steps involved in building physical parts from 3D design data, the main technologies used, their applications, benefits and limitations, as well as the option of hybrid manufacturing integrating additive and subtractive manufacturing. The technologies described in detail comprise a powder-bed fusion of polymers, selective laser melting of metallic materials, laser-directed energy deposition, vat photopolymerisation methods, material extrusion processes for polymers and composites (with a separate chapter dedicated to fused deposition modelling as the most popular additive manufacturing technology), electron beam melting process, and 4D printing.

Next, three chapters discuss the post-processing techniques and the need for standardisation. In particular, one chapter describes laser polishing for adjusting the surface roughness of additively manufactured metallic components. Another one deals with the surface roughness typically resulting from various additive manufacturing technologies and utilisation of conventional machining processes, such as turning, milling and grinding, for post-processing of both metal and polymer parts. The last chapter in this section presents the existing international standards for different additive manufacturing technologies and materials, covering the process and output quality, testing procedures, safety and environmental concerns, etc.

The remaining ten chapters focus on selected materials, applications and methods. Their topics include metal matrix composites processed by laser additive manufacturing, laser-aided metal additive manufacturing and post-processing, 3D printing of functional nanocomposite materials for medical, bionic, electronic, sensing, energy storage and structural devices, the technical and economic impact in the automotive industry, specific challenges of large-size product manufacturing, production of personalised pharmaceutical products, 3D bioprinting towards engineered human tissues and organs, processing of biopolymers for medical applications, development of additive manufacturing using space resources, and the current modelling and simulation approaches for advanced fabrication by the processing of metallic powders.



Editors: Juan Pou, Antonio Riveiro, J. Paulo Davim

Publisher: Elsevier

1st ed., May 2021

ISBN: 978-0-12-818411-0

768 pages

Softcover

Available also as an eBook



Advances in Graphic Communication, Printing and Packaging Technology and Materials

Editors: Pengfei Zhao, Zhuangzhi Ye, Min Xu, Li Yang, Linghao Zhang, Rengao Zhu

Publisher: Springer
1st ed., May 2021
ISBN: 978-9811605024
861 pages, 513 images
Hardcover
Also as an eBook



This volume with the Proceedings of 2020 11th China Academic Conference on Printing and Packaging held in Guangzhou, China, brings the selection of almost 120 peer-reviewed papers.

As for the previous editions, the content is organised into sections covering areas from colour science to novel functional materials. The topics include observer metamerism for assessing neutrality on displays, ink colour matching method based on 3D gamut visualisation, neutral colour correction algorithm for colour transfer between multicolour images, a simulation study on water-based ink transfer in gravure printing, fabrication of 3D graphene electrodes by direct-write printing, peeling strength of solventless lamination films, interactive design of post-press equipment based on virtual reality, and a study on factors influencing luminescence intensity of rare earth complexes, to name a few.

Quaternions for Computer Graphics

Author: John Vince

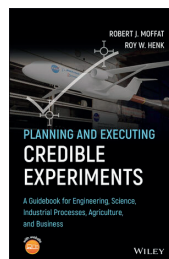
Publisher: Springer
2nd ed., September 2021
ISBN: 978-1447175087
196 pages, 41 images
Hardcover
Also as an eBook



The author of this book explains the concept of quaternions and their use for rotating vectors about an arbitrary axis in a clear and easy-to-read way, helping to gain the understanding necessary for their practical use.

Planning and Executing Credible Experiments A Guidebook for Engineering, Science, Industrial Processes, Agriculture, and Business

With the growing number of studies suffering poor reliability and considering the challenges faced today, credible design, execution, analysis and reporting of experiments gain even more importance. The authors of this book share their deep expertise to guide anyone who needs to experimentally answer questions, including complex ones. The text explains the key role of credibility in research with impact and introduces the basic prerequisites for conducting good experiments. It presents the nature of experimental work and basic concepts, discussing the choice of strategy and tactics. Four chapters deal with experiment planning and refinement while considering the desired accuracy as well as the time and budget requirements. The book guides how to identify the motivating question, choose the approach in terms of techniques, instrumentation, conditions, procedures and data interpretation, and use mapping as a supporting tool to ensure safe and effective operation. The following three chapters provide an overview of fundamental statistical concepts and data distributions, together with the use of the R language, and then present the options for statistical design of experiments and selecting the data points. Then, two chapters discuss in depth how to analyse measurement uncertainty and use uncertainty analysis in experiment planning and execution. Finally, the remaining three chapters cover the phase of debugging, trialling and validation, the ways to trim uncertainty, and good practices in report writing. The book includes many examples, exercises and four appendices with useful information; in addition, it is accompanied by a website providing more resources.



Authors: Robert J. Moffat, Roy W. Henk

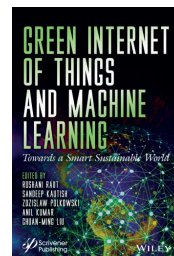
Publisher: Wiley
1st ed., January 2021
ISBN: 978-1-119-53287-3
352 pages
Hardcover
Available also as an eBook

Green Internet of Things and Machine Learning Towards a Smart Sustainable World

Twelve chapters of this book explore the utilisation of machine learning algorithms to improve the energy efficiency of devices and applications and thus achieve a so-called Green Internet of Things. The book explains relevant terms and concepts, introduces techniques for reducing the energy consumption of devices and creating energy-efficient routing infrastructure,

Editors: Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar, Chuan-Ming Liu

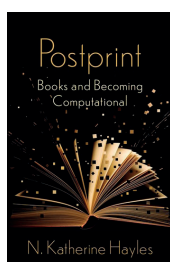
Publisher: Wiley-Scrivener
1st ed., February 2022
ISBN: 978-1-119-79203-1
374 pages
Hardcover
Available also as an eBook



and discusses different aspects of their use in general and in selected areas. The latter include various applications of the Green Internet of Things and machine learning in agriculture and smart farming, healthcare, transportation and banking. The book presents specific examples and case studies, considering the existing possibilities, benefits, disadvantages, challenges, risks and opportunities.

Postprint Books and Becoming Computational

This volume is part of the series The Wellek Library Lectures; namely, it is based on the lectures in Critical Theory given at the University of California, Irvine, in May 2016. While being aware of past developments since Gutenberg's time, N. K. Hayles identifies the second half of the 20th century, when computational media transformed every aspect of print, from creation to production and distribution to reading, as a crucial period within the evolution of print media. Therefore, she suggests calling the present era, after roughly 2000, a postprint and considers its role in the ongoing evolution of humanity, where computational media take part in some of the cognitive tasks. The text introduces the concept of postprint supported by literature references, interviews and well-chosen examples, including the codes used to produce the final print page. It discusses the position and role of university presses, as well as the anxiety connected with the neurological effects of digital technologies and a new kind of illiteracy the postprint can bring.



Author: N. Katherine Hayles

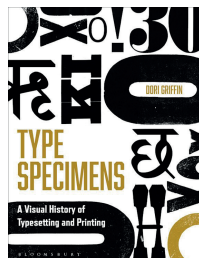
Publisher: Columbia University Press
1st ed., February 2021
ISBN: 978-0-231-19824-0
248 pages
Hardcover
Available also as an eBook

Type Specimens A Visual History of Typesetting and Printing

As reflected in its name, this book outlines the developments in typesetting and printing technologies through the content of type specimens and specimen books. It aimed to provide not only broad access to resources otherwise available only locally but also historical context, global perspective, and visual reference. Individual chapters deal with the early broadsides, printers' manuals, foundry specimen books, industrial methods and materials, hot metal, ephemera, photographic and binary processes, up to digital type.

Author: Dori Griffin

Publisher: Bloomsbury Visual Arts
1st ed., January 2022
ISBN: 978-1-350-11660-3
256 pages, 200 images
Hardcover
Available also as an eBook



Vision

Editors: Andrew Fabian, Janet Gibson, Mike Sheppard, Simone Weyand



Publisher: Cambridge University Press
1st ed., September 2021
ISBN: 978-1108931021
228 pages, Softcover
Also as an eBook

This book brings essays developed from a well-established series of the Darwin College Lectures at Cambridge, where the theme of vision was addressed in 2019. In seven chapters, the experts with different backgrounds elaborate on the biological evolution of eyes, showing their diversity while detailing the morphology and properties of animal and human eyes, especially with respect to photoreceptors and resolution, and explain visions and the processes of perception, as well as colour vision and related phenomena, such as colour constancy and simultaneous chromatic contrast. Further, they examine the role of vision and visual images in science in general, supporting discoveries and understanding, the cameras and telescopes providing the vision of the cosmos, together with their anticipated developments, visions of a digital future with different stages of interaction between human and machine visions, and computer vision from its beginnings to present cutting-edge applications in medicine and autonomous driving.

Kris Sowersby The Art of Letters

Editors: Mark Gowing, Dave Foster



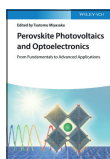
Publisher: Formist
1st ed., July 2021
ISBN: 978-0648596349
800 pages
Softcover

This volume features letterforms by Kris Sowersby of Klim Type Foundry and an essay by Paul McNeil. The selected characters are printed in large size, one per page.

Perovskite Photovoltaics and Optoelectronics From Fundamentals to Advanced Applications

Editor: Tsutomu Miyasaka

Publisher: Wiley-VCH
1st ed., March 2022
ISBN: 978-3527347483
480 pages
Hardcover
Also as an eBook



The first chapter of this volume provides research background and recent progress of perovskite photovoltaics, including printable solar cells. The next six chapters detail the halide perovskite materials, their various properties and synthesis, physics of perovskite solar cells in terms of efficiency, open-circuit voltage and recombination, electric parameters of halide perovskite materials, and hysteresis of current–voltage performance. Eight chapters then describe the use of perovskite materials in different types of solar cells, for quantum dots, light-emitting diode technologies, photodetectors, and x-ray detectors.

Women in 3D Printing From Bones to Bridges and Everything in Between

Editor: Stacey M. DelVecchio

Publisher: Springer
1st ed., July 2021
ISBN: 978-3030707354
205 pages, 106 images
Hardcover
Also as an eBook



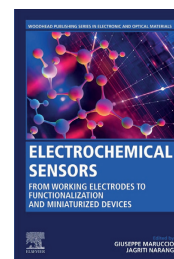
This volume from the Women in Engineering and Science series presents some of the women's contributions to the field of additive manufacturing. The areas include a digital product development platform, patient-specific anatomic models, bone regenerative medicine, inkjet-based 3D printing, the workflow employing laser powder-bed fusion process, direct ink writing of ceramics and ceramic matrix composites for aerospace, printing concrete buildings, and more.

Electrochemical Sensors From Working Electrodes to Functionalization and Miniaturized Devices

The content of this book covers three areas – the basics of electrochemical sensors used for biosensing, the main types of electrodes, and the miniaturised devices. Two chapters introduce the general principle of biosensors, the devices that use a bioreceptor molecule as a sensing element, the ways of their fabrication and the fundamental concepts of electrochemistry, including both bulk and interfacial techniques. Five chapters present the metal-based electrodes, especially those from gold and platinum, together with immobilisation methods used to improve the sensitivity, selectivity, and stability of biosensors, the carbon and carbon paste electrodes with a focus on the advances in carbon nanomaterials, the mercury electrodes and their biosensing applications, the nanostructured electrodes and the related approaches to next-generation biosensors, and the 3D electrodes, which offer many advantages. One chapter deals with the biological recognition elements, discussing both the conventional and synthetic ones. The remaining two chapters review a nanotechnological approach to the miniaturisation of devices, together with the advantages it brings and concerns it raises, and the lab-on-a-chip devices, focusing on the various aspects of microfluidics. Among the printing techniques, the book includes the applications of screen printing, inkjet printing, and microcontact printing.

Editors: Giuseppe Maruccio, Jagriti Narang

Publisher: Woodhead Publishing
1st ed., January 2022
ISBN: 978-0-12-823148-7
316 pages
Softcover
Available also as an eBook

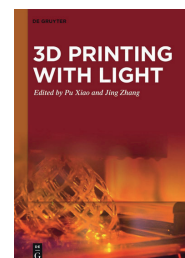


3D Printing with Light

Contributed by the international team of experts in the field, this book reviews the recent progress in 3D printing based on photopolymerisation of liquid resin through controlled irradiation, focusing primarily on chemistry and selected applications. The individual chapters deal with high-performance photoinitiating systems, photoinitiators for two-photon 3D printing, the use of functional dyes, resin design in stereolithography for microfluidic applications, 3D printing of biomaterials, the available technology, dual-wavelength systems, femtosecond laser nonlinear lithography, photocontrolled reversible addition–fragmentation chain transfer polymerisation, and challenges in terms of printing speed and biomedical applications.

Editors: Pu Xiao, Jing Zhang

Publisher: De Gruyter
1st ed., April 2021
ISBN: 978-3-11-056947-6
352 pages, 170 images
Hardcover
Available also as an eBook



Bookshelf

Academic dissertations

Development of Combined Method for Analysis of Facial Images Using Eye Tracking System

The research within this thesis was focused on the field of eye-tracking, namely its application to facial images. The work investigated the influence of observation time and image dimensions on the duration of fixations and recognition performance, also analysing the results for images captured from different angles and the emotion recognition results. In all tests, a combined framework was employed, where the time-spatial analyses were complemented by a new area method utilising the data acquired for the heatmaps, and the results of both approaches were compared.

The theoretical part of the dissertation overviews the human eye, visual perception, methods of its study and related terms, facial anatomy, face perception, the role of observation angles, the basic set of facial emotions and emotion misidentification. The next part describes the experimental setup, choice of face images, test procedures and methods of results analysis. The two main methods used comprise the method evaluating the duration of fixations and the length of saccades and the proposed method based on characterisation of features observed in the image, especially on their area, circumference and circularity. In addition, the analyses considered the recognition performance and response times in the face recognition test, the observation statistics for the three areas of interest, i.e. eyes, nose and mouth, the visit count for the eye area, and the mistakes in emotion recognition evaluated using a substitution matrix. The study proved that the success of recognising and remembering facial images is reflected in the curves depicting its dependence on the observation time and image size. Thus, for the images with sufficient dimensions, it is possible to predict the time needed to achieve satisfactory results. Further, it was shown that profile face images (at 90°) took less time to observe the entire face than frontal images (at 0°), with the transition between 45° in 67.5°. The results confirmed the applicability of the proposed area method for eye-tracking data evaluation, including emotion recognition.

Doctoral thesis – Summary

Author:

Andrej Iskra

Speciality field:

Graphic and Interactive Communications

Supervisor:

Helena Gabrijelčič Tomc

Defended:

3 June 2020, University of Ljubljana, Faculty of Natural Sciences and Engineering Ljubljana, Slovenia

Language:

Slovenian

Original title:

Razvoj kombinirane metode za analizo obraznih slik z uporabo sistema sledenja pogleda

Contact:

andrej.iskra@ntf.uni-lj.si

Further reading:

<https://repozitorij.uni-lj.si/IzpisGradiva.php?lang=eng&id=116791>

Perovskite Solar Cells With Printed Functional Layers

This thesis contributed to the research on perovskite solar cells with carbon back electrode. Its primary objective was to prepare and optimise the layers applied by coating and printing techniques, namely the electron-transport and hole-blocking layer based on TiO₂ or SnO₂, as well as the TiO₂ mesoporous layer and ZrO₂ scaffold layer. The work also investigated different treatments of the glass substrate pre-coated with fluorine-doped tin oxide and their influence on the quality of the thin blocking layers.

The sections in the first part of the dissertation provide the background on perovskite structure and properties, deposition techniques, perovskite solar cell structure, electron-transport layers, scaffold layers, hole-transport layers and back electrode. After defining the aims, the work describes the materials and methods used and presents the results in two main sections. The study included several types of compact blocking layers: the layers spin-

Doctoral thesis – Summary

Author:

Matej Hvojník

Speciality field:

Chemical Engineering and Technology

Supervisor:

Milan Mikula

Defended:

23 August 2021, STU, FCFT, Department of Graphic Arts Technology and Applied Photochemistry Bratislava, Slovakia

Language:
Slovak

Original title:
*Perovskitové solárne články s tlačnými
funkčnými vrstvami*

Contact:
matej.hvojník@gmail.com

Further reading:
*[https://opac.czup.sk/
?fn=detailBiblioForm&sid=
CF9E62B1F4156FE3B4280984D7C8](https://opac.czup.sk/?fn=detailBiblioForm&sid=CF9E62B1F4156FE3B4280984D7C8)*

coated from sol-gel solutions prepared from three common TiO₂ precursors, namely titanium diisopropoxide bis(acetylacetonate), isopropoxide, and butoxide, the spin-coated layers modified by a small addition of TiCl₄ to sol-gel solutions, the layers dip-coated from TiCl₄ solution modified by NiCl₂ · 6 H₂O either directly on the substrate or on the spin-coated TiO₂ layer, and the layers spin-coated from SnCl₂ · 2 H₂O solutions. Individual layers were characterised by optical, atomic force and scanning electron microscopy and spectral techniques. The layers were incorporated in printed mesoporous perovskite solar cells. Based on the measured characteristics, the best efficiency (up to 7.8 %) was achieved for TiO₂ blocking layers from titanium diisopropoxide bis(acetylacetonate) modified by TiCl₄. Deposition of the mesoporous layer and use of ZrO₂ scaffold had only a slight influence. Due to the significant effect of substrate purity on the blocking layer quality and thus the performance of the resulting solar cell observed during the experiments, attention also was paid to the substrate cleaning process. It was shown that 10 s of the low-temperature atmospheric plasma treatment are sufficient to reach a conversion efficiency similar to that achieved when the standard, time-consuming chemical cleaning was used. When both these processes were employed, the efficiency moderately increased. For all treatment modes, the changes induced to the electrode surface and the resulting solar cell are characterised and discussed.

Doctoral thesis – Summary

Author:
Timo Hartus

Speciality field:
Paper and Printing Technology

Supervisor:
Patrick A.C. Gane

Defended:
*19 November 2021, Aalto University,
School of Chemical Technology,
Department of Bioproducts and
Biosystems
Aalto, Finland*

Contact:
timo.hartus@helsinki.fi

Further reading:
*[http://urn.fi/
URN:ISBN:978-952-60-8904-1](http://urn.fi/URN:ISBN:978-952-60-8904-1)*

Thermal Studies of Ink Solvent and Toner Behaviour on Coated Paper: Modelled in Various Printing Methods Using Ink-Coating Component Mixtures and Laboratory Scale Print Tests

The general focus of this thesis was on the amount of energy consumed in print production and its influence on various properties of the resulting output. In particular, the work investigated the possible relationship between energy consumption and the mechanical or optical quality of the print; it also studied the interaction of ink and paper components concerning reaction products that may be formed and have consequences in terms of print quality, recyclability or waste treatment.

The dissertation provides the fundamentals relevant for individual research questions solved within the thesis. These comprise adhesion of toner in electrophotography, setting and drying of inks in the sheet-fed and heatset offset printing, and drying of the water-based inkjet ink. The approaches adopted in the work are presented in detail, including the use of model compounds. The toners were characterised by digital scanning calorimetry, viscosity and surface energy measurements. After toner printing and fixing, the toner adhesion test and adhesion force measurement took place. Also, print gloss and roughness were determined. The experiments in offset studies included, among others, the measurement of splitting force to estimate ink setting, ink and ink-on-paper tack measurements, and thermal and FTIR characterisation. The quality of inkjet prints was characterised using image analysis combined with print smudge and abrasion resistance testing, whereas the model materials were subjected to thermal analyses. For electrophotography, the results show a clear connection between melting energy and print quality. The studies of offset materials and processes demonstrated a more complex behaviour and provided insight into its various aspects, such as poorer abrasion resistance due to fibre roughening caused by high drying temperature. Among the findings from the inkjet ink studies, the effect of water and solvent specific energy and mass loss ratios on drying time and abrasion resistance is shown. The tailored methods used for testing and evaluation also represent a valuable outcome of the work.

Events

SPIE events

SPIE Photonics Europe 2022

SPIE. PHOTONICS
EUROPE Strasbourg, France
3–7 April 2022

The 2022 edition of this event is held in person; the recordings, posters and other content will also be later available on demand (9–15 May). The programme again includes the 3D Printed Optics and Additive Photonic Manufacturing conference. The topics include laser bioprinting for organ-on-chip and sensor applications, 3D-printed optical components with properties controllable by external light stimuli, improving print accuracy of volumetric additive manufacturing, the application of volumetric 3D printing for flexible gradient index lenses, and femtosecond direct laser writing as a technology for complex micro-optics, from a 3D-printed micro-pinhole camera to ultra-compact wide-angle cameras, up to a monolithic spectrometer. The use of different 3D printing technologies is also presented in other papers, such as in the one dealing with laser-induced forward transfer for drug thin-film printing. Other papers discuss the characterisation of 3D-printed materials and objects, for example, using the full-field optical analysis.

SPIE Defense + Commercial Sensing 2022

SPIE. DEFENSE+
COMMERCIAL
SENSING Orlando, Florida, USA
3–7 April 2022

This SPIE event taking place the same days, but on the opposite side of the Atlantic Ocean, also features some contributions dealing with the utilisation of 3D printing in different areas, such as those presenting the 3D-printed polymer-based flexible electrodes for reverse electrowetting on dielectric energy harvesting, the development of a gastric resident electronics system based on the multiscale integration of nanomaterials in an extrusion-based 3D printing process as a part of the research towards a 3D-printed self-learning robot and free-form biomedical electronics, and the 3D-printed optomechanical positioners for aerospace metrological instruments.

Online Print Symposium 2022

Munich, Germany
28–29 April 2022

**ONLINE
PRINT
SYMPOSIUM** 2022

After the last year's edition postponed to September, in 2022 this event returns in its traditional spring term. Topics of the presentations include new opportunities for internationalisation of online print, the lessons learned in the web-to-print business development, benefits of finding customers among companies, the role of automation in the change of the online-print industry, the innovative solutions enabling customised textile production, different examples of the technology driven by artificial intelligence, and more.

Fairs and other events returning to the in-person format

While some events continue in the virtual format, others are announced to take place in person in 2022. On 5–7 April, the 14th 3D Printing Days take place in Kielce, Poland. The London Book Fair (UK) is held on the same days, with the sessions available later on demand (11–29 April). In France, the postponed 9th edition of the C!Print Lyon tradeshow can be visited on 10–12 May. Two weeks later, on 24–27 May, Graphispag takes place in Barcelona, Spain. The postponed 67th Annual Pulp and Paper Industry Conference is planned for 12–16 June in Ontario, Canada.

Intergraf events

INTERGRAF This year's Intergraf Currency+Identity conference and exhibition, open exclusively to security printers and other stakeholders in this area, is also held as an in-person event in Lyon, France (6–8 April). Later on 20 May, the Print Matters for the Future conference is held in Stockholm, Sweden, jointly with NOPA, the Nordic Offset Printing Association.

2022 Continuous Improvement Conference

Scottsdale, Arizona, USA
1–4 May 2022

**CONTINUOUS
IMPROVEMENT** MAY 1-4 • SCOTTSDALE, AZ

This established annual event, which is after the merger of Printing Industries of America (PIA) and Specialty Graphic Imaging Association (SGIA) presented by PRINTING United Alliance, offers the pre-conference workshops and three days of keynotes and lectures dedicated to lean manufacturing and other approaches improving management and quality in printing and converting companies.

IMI events

In the USA, the IMI Inkjet Conference 2022 is held on 4–5 May in Orlando, Florida, preceded by the IMI Inkjet Innovation Academy, taking place in the same venue on 2–3 May. The academy offers three comprehensive, one-and-a-half-day courses focused on the industrial inkjet system design, theory of inkjet technology, and evaluation and opportunities of inkjet-printed electronics. The two-day agenda of the conference covers the recent developments in the field, including 2.5, 3D and 4D material deposition, multimaterial printing, decreasing energy consumption and pollution with digital dyeing of textiles, the importance of wetting additives, and more. A week later, on 9–12 May, Digital Print Europe 2022 takes place in Barcelona, Spain, keeping the same format with the Inkjet Academy course followed by the IMI Europe Digital Printing Conference.



CPES2022

Brampton, Ontario, Canada
17–18 May 2022

This Canadian symposium focused on printable, flexible and wearable electronics in 2022 also returns to the in-person format. The programme covers e.g. the circular economy, advances in manufacturing, materials innovations, cybersecurity, smart packaging, and textile electronics.



I3S 2022 9th International Symposium on Sensor Science

Warsaw, Poland
20–22 June 2022

In 2022, the announced presentations discuss, among others, the influence of paste rheology on the performance of screen-printed electrochemical sensors and the potentiometric cell for atrazine sensing made by screen printing.



TAPPICon 2022



Charlotte, North Carolina, USA
30 April to 4 May 2022

This event organised by the Technical Association of the Pulp & Paper Industry covers the areas of coating and graphic arts, management, papermaking, tissue papermaking additives, papermaking fundamentals, process control, recycled paperboard, reliability and maintenance. Also, it offers the Mentor Match Speed Networking event for young professionals and the Women's Summit, with this year's key topic for the latter being Trusted Teams. The technical programme for coating and graphic arts includes panel discussions on fibre recycling as a critical component of sustainable packaging and the role of collaboration across the value chain in the successful development of compostable packaging, presentations of advances in the production of barrier layers and coating processes in general, novel test methods for barrier coatings, the influence of coating pigment particles on offset printing, the relationship between the coating layer and printing defects in a high-quality flexography, and the fully repulpable and biodegradable thermally sealable paper. In addition, this track presents the major topics for research and development in the field, such as perfecting circularity.

INMA World Congress of News Media



<https://www.inma.org>
5–26 May 2022

The International News Media Association presents this event again in the virtual format, this year comprising seven modules scheduled during May and focused on leadership, smart data, subscriptions, advertising, product innovation, newsrooms, and what is next. The lectures deal with the emerging trends in news media, the maturing data organisation, bundling new value as subscription models evolve, what and how is sold, how product mindsets are lifting results, newsrooms and the bridge to the business of news, and the growth path ahead for news media.

HOPV22

14th Conference on Hybrid and Organic Photovoltaics

Valencia, Spain
19–25 May 2022



After two online editions, this event organised by nanoGe supported by Fundació Scito returns in part to the in-person format, taking place online on 19 and 20 May and face-to-face from 23 to 25 May. The announced keynote speakers are Edward Sargent discussing the progress in inverted perovskite photovoltaics in terms of their thermal and operational stability, with a focus on removing the barrier to electron extraction at the 2D/3D interface, Jenny Nelson presenting luminescence and molecular modelling as tools to probe structure-property-performance relationships at molecular heterojunctions, and Christoph Brabec providing an insight into advanced interface engineering for the long operational lifetime of organic and perovskite solar cells. The topics of the technical presentations include, for example, the bifacial fully printable low-dimensional perovskite solar cells.