TOPICALITIES

Edited by Markéta Držková

CONTENTS

News & more

Recently granted patents in the area of printed electronics

This brief overview presents the patents retrieved for the searched term "printed electronics" and published since the beginning of 2020. Among over 500 patents, the most represented are the U.S. (37 %), Chinese (21 %) and Korean, Japanese and European (each above 10 %) ones. The rest comprises the Taiwanese, Canadian, Australian, Russian, Spanish, German and Luxembourgish patents. The inventions relate to a wide range of fields and applications. This fragmentation is reflected in the number of assignees; there are less than 20 % of assignees with more than one patent from this selection, and only a few of them with more than five. Both academic and commercial sectors are represented, with the assignees in the latter ranging from global corporations to small companies. The following sections present those with the most entries in the list.

TactoTek

This company is a spin-off from VTT, Technical Research Centre of Finland, and develops the technology for injection-moulded structural electronics, seen as a manufacturing method that uses less plastic and reduces greenhouse gas emissions. The most recent one among its numerous patented inventions is US 10,849,235 B1 Method of manufacture of a structure and structure, filed in May 2020, which presents different approaches to producing a functional electronics assembly by using a suitable forming process. The other patents granted during past months include, for example, US 10,642,433 B2 Multilayer structure with embedded multilayer electronics, US 10,675,834 B2 Integrated multilayer structure for use in sensing applications and method for manufacturing thereof, US 10,827,609 B2 Ecological multilayer structure for hosting electronics and related method of manufacture, and US 10,928,583 B2 Illuminated multilayer structure with embedded light sources.

Xerox Corporation

The Xerox patents related to printed electronics deal with various topics. These include CA 3 006 257 C Memory cells and devices, fabricated on a flexible substrate and utilising a ferroelectric memory layer and an adhesive layer comprising a crosslinked mixture of acrylic polyol, an alkylene urea-glyoxal resin and an acid catalyst, which are already protected by US 10,115,785 B1. Memory cells are described also in US 10,593,684 B2 Printed electronic devices exhibiting improved yield, being achieved by suitable modifications of contact pads. Another application shows US 10,799,042 B2 Point-of-purchase (POP) display that includes a printed electronic device and other components necessary for its use, while it can be shipped as flat panels or sheets as usual POP displays. Yet another one is presented in US 10,821,658 B2 Conductive three-dimensional articles, prepared by printing using a proper combination of structural material and conductive ink.

Some of the most recent Xerox patents further develop the inventions concerning the composition of inks and layers for printed electronics applications, presented in this section in JPMTR Vol. 9, No. 1 (2020). These include

PRINTING United Alliance grows further

Less than one year since SGIA, the Specialty Graphic Imaging Association, and PIA, Printing Industries of America, merged and became PRINTING United Alliance on 1 May 2020, another merger was announced this January. Idealliance, originally organised as the Computer Section of the Printing Industries of America in 1966, soon renamed to the Graphic Communications Computer Association, later to the Graphic Communications Association (GCA), and then turned into an independent association called the International Digital Enterprise Alliance in 2001, became a part of PRINTING United Alliance on 1 March 2021.

Idealliance will continue to operate and provide its services as a division of PRINTING United Alliance, expanding its efforts in providing global standardisation, training and certification programmes to all graphic communication professionals in the printing and packaging supply chain. The numerous technical guidelines and specifications of Idealliance are classified into four sectors. Those for print media creation, production and workflows include, among others, the ECG (Expanded Color Gamut) project, XCMYK, an expanded-gamut CMYK printing method, PrintWide, a new large-gamut CMYK dataset, SWOP (Specification for Web Offset Publications), G7 specifications for achieving grey balance, and GRACoL guidelines and resources, such as colour settings, ICC profiles, characterisation data sets, control wedges, etc. Those for cross-media, digital-asset creation, management and publishing include, for example, PRISM Metadata and Controlled Vocabularies. The remaining specifications are provided for either mail supply, fulfilment and postal services or paper supply chain.

Activities of KCL Pilot Plant

KCL Pilot Plant, one of the 15 ATI (Advanced Technologies for Industry) Technology Centres in Finland as currently listed on the EU's ATI project website, provides services and expertise in biomaterial processing, mechanical pulping, stock preparation, paper making, coating, calendering, printing, finishing, laboratory testing, and process design and building. Adapting to the ongoing pandemic situation, KCL Pilot Plant offers a remote video-stream connection employing mobile cameras placed on commonly agreed locations in the process, in addition to appropriate communication via a trial-specific platform.

The company now takes part in the new EU project INN-PRESSME, the open innovation ecosystem for sustainable plant-based nano-enabled biomaterials deployment for packaging, transport and consumer goods. This four-year project, which started on 1 January 2021, is coordinated by VTT, Technical Research Center of Finland, and funded as one of the four projects under Horizon 2020 topic 'Open Innovation Test Beds for nano-enabled bio-based materials'. With 27 partners from nine European countries involved, it aims at replacing petroleum-based products with bio-based packaging, energy and vehicle solutions and other consumer goods by supporting European companies to scale up their nano-enabled biomaterials and processes with reduced risks and accelerated market access. KCL Pilot Plant contributes its services of recycling testing for fibre-based materials.

KCL Pilot Plant also newly offers printing-trial services for the packaging and board customers on an 8-colour reel-fed flexographic printing press, in addition to the offset and inkjet lines. The machine enables trial-specific modifications of print layout, ink type and viscosity, anilox rolls, printing plates, and parameter settings according to particular needs in printability studies of packaging paper and board substrates.

US 10,899,940 B2 Interlayer printing process, where an interlayer is deposited and cured on a substrate before depositing and curing a conductive metal ink composition to form a solid metal trace, and US 10,723,887 B2 UV curable interplayer for electronic printing (the name as filed and published), claiming a multilayer structure comprising the interlayer between a substrate and a conductive layer formed from a UV-curable composition. Other types of compositions are claimed as well, such as US 10,577,515 B1 Dielectric ink composition, which is UV-curable and suitable for inkjet or aerosol-jet printing, US 10,767,069 B2 Aqueous carbon nanoparticle ink composition for resistors, and compositions with eutectic metal alloys, namely US 10,800,948 B2 Conductive adhesive compositions and method for the same, with gallium, tin and indium, US 10,843,262 B2 Compositions comprising eutectic metal alloy nanoparticles and US 10,947,424 B2 Adhesive composition comprising eutectic metal alloy nanoparticles, both the latter with bismuth, tin and indium.

Beijing Dream Ink Technology

This company develops the technology for printing liquid metal instead of conductive polymers or nanoparticle materials. The technology is protected by several Chinese patents and utility models, including, among others, CN 107 337 964 B Colored liquid metal printing ink and preparation method thereof, CN 210 478 087 U Printed electronics and printed electronics manufacturing system, CN 211 868 913 U Desktop printing inking device, and CN 210 143 156 U Circuit substrate and flexible film circuit.

NTN Corporation

While the main product range of NTN comprises bearing products and precision machinery, attention is also paid to research and development in other fields. This is reflected in a series of recently granted patents dealing with a fine-coating method using a special needle mechanism capable to deposit materials having a wide viscosity range, including a high-viscosity liquid containing metal powder. This microscopic coating technology, described, for example, in JP 6 835 506 B2 Liquid coating unit and liquid coating device and JP 6 799 046 B2 Coating method and coating equipment, is primarily intended for pattern correction, more particularly for repairing a broken portion of a wiring pattern formed on a substrate. However, as stated in NTN Report 2020, in collaboration with Osaka University towards the development of cell chips, the coating of high-viscosity solutions containing cells onto the chips can be achieved with this technology.

South China University of Technology

Among the numerous Chinese patents granted to this academic organisation, those related to printed electronics describe conductive ink formulations, such as CN 107 739 554 B Rapid-gelation zirconia ink-jet printing ink and preparation method and application thereof and CN 108 587 326 B Silver nanowire transparent conductive ink and preparation method and application thereof.

Stora Enso

The patents recently granted to Stora Enso in several European and American countries cover different methods used in the production of printed electronics, such as US 10,887,998 B2 Method and an arrangement for producing electrically conductive patterns on substrates, or their applications.

Bookshelf

Handbook of Image Engineering

This handbook builds on the author's experience in the education and research of image engineering, the field which is understood as an overall framework and system for the comprehensive research and integrated application of various image technologies. Near ten thousand entries of the handbook, which covers the common concepts, related principles, practical technologies, and specific methods, are systematically organised into parts, chapters, sections and subsections. Each chapter and section begins with a concise definition based on selected references that can be used as the source for further reading. The entries are based on recent literature, providing the appropriate explanations, examples, analyses, and discussions. The text is supported by numerous figures, tables, and formulas. The cross-references to other entries are marked in bold or, where suitable, literally specified at the end of a given entry. All terms are listed in the index having almost a hundred pages.

The first part provides image fundamentals. Its eight chapters introduce image basics, engineering, acquisition devices and modes, digitisation, display and printing, storage and communication, together with the related knowledge comprising basic mathematics, statistics and probability, signal processing, tools, and means.

The second part, with over 450 pages the longest one, deals with image processing. In 14 chapters, it presents pixel spatial relationship, image transforms, point and mask operations for spatial domain enhancement, frequency domain filtering, image restoration, repair and recovery, reconstruction from projection, coding, watermarking, and information security, colour and video image processing, and multi-resolution image.

Twelve chapters of the third part are dedicated to image analysis, introducing segmentation, edge detection, object segmentation methods, segmentation evaluation, object representation and description, feature measurement and error analysis, texture, shape and motion analysis, image pattern recognition, and biometric recognition.

The fourth part explores image understanding, a high level of image engineering. Eleven chapters deal with the theory of image understanding, 3D representation and description, stereo vision, multi-image and single-image 3D scene reconstruction, knowledge and learning, general image matching, scene analysis and interpretation, image information fusion, content-based retrieval, and spatial-temporal behaviour understanding.

Finally, the fifth part combines other relevant entries, with seven chapters on related theories and techniques, optics, mathematical morphology for binary images and grey-level images, visual sensation and perception, application of image technology, and an overview of international organisations and standards.

Author: Yu-Jin Zhang

Publisher: Springer
1st ed., January 2021
ISBN: 978-981-15-5872-6
1 999 pages, 790 images
Hardcover
Available also as an eBook

Functional Textiles and Clothing 2020

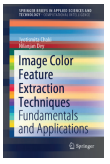
Editors: Abhijit Majumdar, Deepti Gupta, Sanjay Gupta

Publisher: Springer
1st ed., December 2020
ISBN: 978-9811593758
219 pages, 74 images
Hardcover
Also as an eBook

This volume presents the selected papers from the 2nd International Conference on Functional Textiles and Clothing held at the Indian Institute of Technology in New Delhi, India, in February 2020. The contributions are divided into four parts that deal with testing, characterisation and instrumentation, functional and protective clothing, functional printing and finishing, and sustainable production and supply chain. The topics in the third part include photoluminescent printed fabrics to aid nighttime navigation, statistical optimisation of fire protective finishing of jute fabric, application of protective finishes on denim with analysis of its multifunctional performances, and development of eco-friendly multifunctional textiles.

Image Color Feature Extraction Techniques
Fundamentals and Applications

Authors: Jyotismita Chaki, Nilanjan Dey

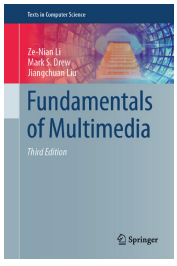


Publisher: Springer
1st ed., June 2020
ISBN: 978-9811557606
95 pages, 53 images
Softcover
Also as an eBook

This book from SpringerBriefs in Applied Sciences and Technology covers the colour feature extraction techniques used in content-based image retrieval. The first chapter introduces colour spaces and models, colour quantisation methods, and both pseudocolour and full-colour image processing. Three chapters then review the histogram-based, MPEG-7 and other image colour features. The applications of image

Fundamentals of Multimedia

The third edition of this comprehensive textbook on multimedia appeared 17 years after the original and 7 years after the second one. The content of the current edition is substantially revised and updated to reflect the rapid growth and evolution in the field, including the topics such as 360° video, new-generation social, mobile and cloud computing for human-centric interactive multimedia, and deep learning for multimedia processing. On the other hand, the structure of the book remains mostly unchanged. The first part introduces the topic, including the components of multimedia, appropriate software tools and issues in multimedia production; also, it provides the basics of multimedia data representations, from graphics, images and colours to video and audio. The second part reviews the multimedia data compression, i.e. the algorithms for lossless or lossy compression, image compression standards, video compression techniques, video coding using MPEG, H.264 and H.265 standards as well as a new H.266 standard, and audio compression techniques. The third part covers multimedia communications and networking, from network services and protocols to multimedia content distribution using the internet, including wireless and mobile networks. Also, the chapter on cloud computing for multimedia services was moved into this part from the fourth one, which was renamed and contains a new chapter on augmented and virtual reality, besides those dealing with online social media sharing and content-based retrieval in digital libraries.



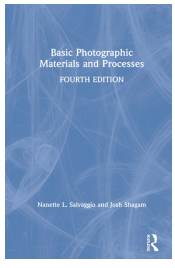
Authors: Ze-Nian Li, Mark S. Drew, Jiangchuan Liu

Publisher: Springer
3rd ed., February 2021
ISBN: 978-3-030-62123-0
849 pages, 390 images
Hardcover
Available also as an eBook

Basic Photographic Materials and Processes

Published 11 years after the previous edition, the current one, co-authored by Josh Shagam, was significantly revised and reorganised to provide a solid technical background on the current photography. The first section explains the fundamentals of image capture, namely light and photometry, optics, digital camera technology, photographic exposure, lens filters, and motion video. The second one covers image processing, dealing with demosaicing and interpolation, digital asset management, digital tone reproduction, software filters, camera characterisation, image quality, and image compression. The last one reviews the basics of output, from colour vision and colour management to display technology, printing and physical media.

Authors: Nanette L. Salvaggio, Josh Shagam

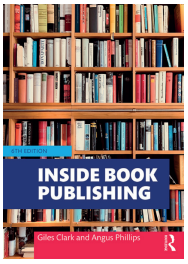


Publisher: Routledge
4th ed., October 2019
ISBN: 978-1-138-74436-3
384 pages, 390 images
Hardcover
Available also as an eBook

Inside Book Publishing

The current edition of this highly informative and praised book with many reprints and translations was published over 30 years since the first one appeared in 1988 and five years after the previous edition. Among major changes in the book publishing industry since the fifth edition from 2014, the authors highlight the slowing growth in the sale of ebooks and the fast-growing sales of audiobooks, the strong increase in self-publishing, disruption in the sale of printed textbooks in the US, and open-access publication moving into the area of academic books. On the other hand, they mention the resilient sale of printed books, prospering children's publishing and publishers retaining their authors.

The book introduces the publishing industry and markets, major business trends, digital transformations, adaptation and innovation, and tracks the development of modern trade publishing in the UK. Next, it explores publishing for educational, academic and professional markets, and provides the characteristics of the main publishing sectors. The following four chapters deal with creating and protecting value in publishing, the author, self-publishing and agents, commissioning, the author contract and editorial development. Further, the text details the processes and techniques used in the design and production of books, their marketing, sales and distribution, with rights sales discussed in the next chapter. One chapter presents the sales channels for books in the UK. Finally, the last one reviews how to get into publishing. Besides a glossary, the text is complemented by contributions from industry experts on a wide range of relevant topics, including the new ones dealing with the global audiobook market, crowdfunding, self-publishing, and the role of the agent, among others.



Authors: Giles Clark, Angus Phillips

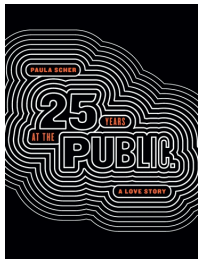
Publisher: Routledge
6th ed., August 2019
ISBN: 978-1-138-57438-0
420 pages
Hardcover
Available also as an eBook

Twenty-Five Years at the Public
A Love Story

In this volume, Paula Scher presents a quarter-century of the brand and identity development for the Public Theater in New York, including design roughs as well as hundreds of finished posters and other matter – not only printed but also integrated into the theatre's facade and interior.

Author: Paula Scher

Publisher: Princeton Architectural Press
1st ed., September 2020
ISBN: 978-1-61689-864-9
256 pages, 400 images
Softcover



colour features in the recognition and detection of selected elements are presented in the last chapter.

Advances in Design, Music and Arts

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

Publisher: Springer
1st ed., September 2020
ISBN: 978-3030556990
717 pages, 273 images
Hardcover
Also as an eBook

This large volume comprises the papers accepted for the 7th Meeting of Research in Music, Arts and Design, EIMAD 2020, which was held last year in May as an online event. The content is organised into four parts. The first one covers the topics from the area of design, communication and education, such as the creative graphic thinking and contemporary graphic representation, semantic analysis of brand mark creation, research project management in communication design, technological empowerment of communication designers, the magazine case study in printing laboratories practices, and digital transformation at school of arts and design accelerated by the COVID-19 pandemic.

Graphic Design Play Book
An Exploration of Visual Thinking

Authors: Sophie Cure, Aurélien Farina

Publisher:
Laurence King Publishing
1st ed., June 2019
ISBN: 978-1786273963
80 pages, 150 images
Softcover

In this book with the appropriate quality of design and production, the authors provide entertaining and creative exercises that convey the basic principles of graphic design and help to develop visual thinking. Its four sections deal with typography, posters, signs, and identity.

Introduction to Flat Panel Displays

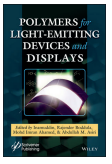
Authors: Jiun-Haw Lee, I-Chun Cheng, Hong Hua, Shin-Tson Wu

Publisher: Wiley
2nd ed., September 2020
ISBN: 978-1119282273
376 pages
Hardcover
Also as an eBook

The new edition of this guide covers the advances in technologies for flat panel displays and improvements in their performance achieved during twelve years since the original publication in 2008, including the development of head-mounted displays for virtual and augmented reality applications. The updated and extended text now comprises the chapters with an overview of flat panel displays, related colour science and engineering, thin-film transistors, liquid crystal displays including those enhanced with quantum dots, light-emitting diodes, organic light-emitting devices, reflective displays, fundamentals of head-mounted displays for virtual and augmented reality, and touch panel technology.

Polymers for Light-Emitting Devices and Displays

Editors: Inamuddin, Rajender Boddula, Mohd Imran Ahamed, Abdullah M. Asiri



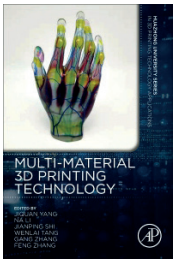
Publisher:
Wiley-Scrivener
1st ed., May 2020
ISBN: 978-1119654605
288 pages, Hardcover
Also as an eBook

This new book reviews the applications of polymer light-emitting devices and displays, devices made by solution processing, modelling and design of new organic derivatives for highly efficient blue emitters, light-emitting diodes utilising conjugated polymers or electrospun materials, luminescent polymer light-emitting devices and displays, polymer liquid crystal devices and displays, and hybrid inorganic–organic diodes emitting white light.

Multi-material 3D Printing Technology

This book is intended for engineers as well as researchers in the area of advanced 3D printing technologies that enable the fabrication of heterogeneous objects. The introductory chapter outlines the classification of such objects, their characteristics and applications, as well as the technologies for their design, manufacturing and prototyping. The particular focus is on the modelling aspects, covered in four chapters. These include 3D models and data formats, static modelling of heterogeneous objects with a description of methods used for the acquisition of network nodes, voxel-based and contour-based modelling, modelling for dynamic heterogeneous objects, where the authors discuss material and functional models, mapping of geometric structure and materials, multi-material property representation, and dynamic material change design, as well as the visualisation of models, i.e., colour file formats and material mapping visualisation methods, among others. The following two chapters present the materials and technologies used for 3D printing of heterogeneous objects, while the applications of heterogeneous parts based on 3D printing are presented in the last one. Among the materials, the text describes different types of 4D printing materials, conductive materials, and biological 3D printing materials. The examples of utilisation include a number of applications in the areas of biomedical engineering, defence engineering, industrial manufacturing and manufacturing of functional parts.

Authors: Jiquan Yang, Li Na, Jianping Shi, Wenlai Tang, Gang Zhang, Feng Zhang

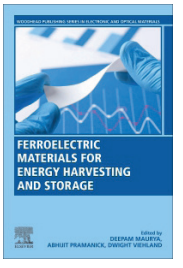


Publisher: Academic Press
1st ed., February 2021
ISBN: 978-0-08-102991-6
232 pages
Softcover
Available also as an eBook

Ferroelectric Materials for Energy Harvesting and Storage

Contributed by several authors and author teams, this book provides the fundamental background on ferroelectrics and related materials and then, in eight chapters, explores the topics of solar energy harvesting, thermal energy harvesting, vibration-energy harvesting from structures leveraging flexoelectricity (with polarisation induced by strain gradient), modelling and identification of nonlinear piezoelectric material properties for energy harvesting, wind-energy harvesting using piezoelectric materials, biomechanical energy harvesting with piezoelectric materials, the harvesting of stray magnetic field for powering wireless sensors, and ferroelectric ceramic capacitors for electrical energy storage, both lead-based and lead-free.

Editors: Deepam Maurya, Abhijit Pramanick, Dwight Viehland



Publisher: Woodhead Publishing
1st ed., October 2020
ISBN: 978-0-08-102802-5
372 pages
Softcover
Available also as an eBook

Bookshelf

Academic dissertations

Printed Electrochemical Light Cells Based on Biocompatible and Biodegradable Materials

Doctoral thesis – Summary

Author:
Johannes Zimmermann

Speciality field:
Photonic Materials and Devices

Supervisor:
Gerardo Hernandez-Sosa

Defended:
6 February 2019, Karlsruhe Institute of Technology, Light Technology Institute Karlsruhe, Germany

Language:
German

Original title:
Gedruckte elektrochemische Leuchtzellen auf Basis von biologisch kompatiblen und biologisch abbaubaren Materialien

Contact:
johannes.zimmermann@innovationlab.de

Contributing to the research on sustainable electronics, this thesis was focused on light-emitting electrochemical cells based on biomaterials. They consist of a single active layer that can be deposited from the liquid phase and thus can be produced cost-efficiently by printing techniques. The aim was to develop light-emitting devices, which are substantially based on biocompatible and biodegradable materials, mechanically flexible, and produced by digital printing to enable easy modification of the layout without increasing the production costs.

The dissertation provides the theoretical background on the electronic properties of organic semiconductors, the charge injection process, the structure, working principle, and types of light-emitting electrochemical cells, as well as the methods for optoelectrical measurements. After specifying the selected materials, ink formulation, fabrication and characterisation methods used, it systematically deals with the properties of biomaterial-based solid-state electrolytes and their combination with commercially available emitters, their utilisation in the active layer and optimisation of its performance, and finally the fabrication and properties of partially or fully printed light-emitting electrochemical cells employing the studied biomaterials. For the best performing system comprising Super Yellow with poly(caprolactone-co-trimethylene carbonate) and tetrabutylammonium bis(oxalato)borate, a maximum luminance of approx. 12 000 cd/m^2, a turn-on voltage of 3.7 V, a maximum efficiency of about 2 cd/A and an operational lifetime of over 100 hours were achieved with a reference electrode system on the glass. In the case of fully printed light-emitting electrochemical cells on an ultrathin biocompatible Parylene C film, these parameters achieved the values of 900 cd/m^2, 6.7 V, 1 cd/A and over 8 hours, respectively.

Advanced Additives for Radical Photopolymerization

Doctoral thesis – Summary

Author:
Paul Gauss

Speciality field:
Chemistry – Photopolymerisation

Supervisors:
Robert Liska
Patrick Knaack

Defended:
26 March 2019, Vienna University of Technology, Institute of Applied Synthetic Chemistry Vienna, Austria

Contact:
paul.gauss@genera3d.com

The aim of this thesis was to develop a new generation of non-aromatic initiator systems as an alternative for potentially hazardous aromatic ketone initiators. This topic is important, among others, for food packaging and medical applications of UV-curable systems, which require biocompatible and harmless photoinitiators. The second goal was to find new chain transfer agents to further improve the material properties of radical photopolymers.

After introducing the basics of radical photopolymerisation and defining the objectives, the dissertation is organised into two main parts describing the research on novel photoinitiators and chain transfer reagents, respectively, with the experimental details provided in the last part. The work documents a comprehensive approach. In the search of new photoinitiators, 23 compounds in total were selected among both the commercially available ones and those to be synthesised. All were classified into five groups comprising the simple aliphatic α-ketoesters, compounds derived by the modification of the ester moiety, compounds derived by the modification of the alpha carbonyl, long-wavelength UV initiators, and long-wavelength visible light

initiators. Next, the work describes the methods used to synthesise the required compounds. The preliminary curing tests with 19 compounds that were either available or successfully synthesised then showed nine of them to be active as photoinitiators, with each group represented by at least one. These compounds were further investigated and compared with the reference photoinitiators. The tests employed the UV-Vis characterisation and photo-DSC measurements in different monomer systems (an acrylate system, methacrylates, and also hydrogels) and at different wavelengths, UV-aging of polymers, photolysis studies to provide more information about initiation mechanisms, and the cytotoxicity by cell incubation tests. The work presents a new class of initiators with high reactivity and colour stability of the resulting cured polymers, where a high potential to replace the standard Norrish type II initiators is seen especially for the simple ketoesters, such as ethyl pyruvate (ethyl 2-oxopropanoate). A similarly thorough approach was applied in the case of studies dealing with the control of chain transfer, investigating new reagents based on oxy-acrylates for the addition–fragmentation chain transfer and cyclohexadienes for the chain transfer by hydrogen abstraction.

Doctoral thesis – Summary

Author:
Canlin Ou

Speciality field:
Materials Science and Metallurgy

Supervisor:
Sohini Kar-Narayan

Defended:
2 December 2019,
University of Cambridge, Department of Materials Science and Metallurgy
Cambridge, United Kingdom

Contact:
oucanlin@gmail.com

Aerosol-Jet Printed Nanocomposites for Flexible and Stretchable Thermoelectric Generators

The focus of this thesis was on thermoelectric generators that are expected to become one of the important energy harvesting technologies. These devices are based on thermoelectric materials producing an electric current when subjected to a temperature gradient. The work addresses the lack of such materials being suitable in terms of performance, energy conversion efficiency, processability, cost and harmlessness, as well as with respect to the required mechanical properties of the resulting device. The solution employs organic–inorganic thermoelectric nanocomposites and adopts a material engineering approach to achieve desirable properties concerning both the thermoelectric performance and intended applicability of thermoelectric generators. The dissertation identifies the challenges and provides the theoretical background on energy harvesting, thermoelectrics, microscale additive manufacturing techniques, functionally graded thermoelectric materials, and approaches to produce stretchable thermoelectric generators. In the next chapter, it presents the methods used within the work, from nanomaterial fabrication and structural characterisation to printing, ink preparation, post-processing, measurements, and tests, up to the finite element analysis and thermoelectric generator fabrication. The selection of materials includes poly(3,4-ethylenedioxythiophene) poly(styrene-sulfonate) (PEDOT:PSS) as the organic polymer matrix, Bi_2Te_3 and Sb_2Te_3 as inorganic nano-fillers for the enhancement of Seebeck coefficient at or near room temperature, and multiwall carbon nanotubes for the improvement of electrical conductivity. The aerosol-jet printing was chosen as a scalable technique enabling mixing different ink materials in situ to form nanocomposite structures and dynamically optimise their composition and properties. Attention was also paid to post-processing treatment to further enhance the thermoelectric properties. The work presents the successful fabrication of high-performance and, at the same time, flexible thermoelectric generators based on Bi_2Te_3/Sb_2Te_3 nanocomposites and their further improvement by incorporating multiwall carbon nanotubes, which also increased the mechanical flexibility and fatigue robustness. As the next step, compositionally graded thermoelectric composites were developed to ensure better performance across the entire intended temperature range. Finally, free-standing stretchable thermoelectric structures were produced.

Events

Virtual.drupa

https://virtual.drupa.com
20–23 April 2021

The traditional drupa fair is now planned for 2024, eight years since the previous edition. After several changes of dates due to different reasons, the in-between event for the print industry organised by Messe Düsseldorf is held online, in four days only. The live content is divided into three sections – first, the conference area with the programme based on four global trend topics identified as artificial intelligence, circular economy, connected consumer and platform economy; second, the exhibition space with online showrooms for the presentation of innovations and products; and third, the networking plaza for business meetings and matchmaking with visitors and exhibitors worldwide.

The breadth of coverage is well illustrated by the list of web sessions by topic, which includes, in alphabetical order, 3D printing, additive manufacturing, best case, branding, brand story, design, fashion, functional printing, future technologies, green printing, Industry 4.0, inkjet, interior decoration, multisensory marketing, packaging, packaging production, printed electronics, robotics, screen printing, security printing, smart and intelligent packaging, sustainability, textile printing, and workflow automation.

The conference area offers sessions in two parallel streams and with three confirmed keynote speakers. The keynotes on the first and last day of virtual.drupa, both by Michael Gale, deal with artificial intelligence. Their topics are 'Small steps and giant leaps for your AI in a circular economy', discussing necessary decisions and showing the simple steps based on thousand case studies, and 'The AI opportunity – A dawn of a new age for you with the right AI schematic', with a virtual facility to simulate where and how AI can help change the economics of a business. On the second day, the keynote by James Sommerville named 'The creative business model of tomorrow. The cusp of another revolution' explores the ways to work as distributed teams and networks and to keep the business model human-centred to create a competitive edge for growth. The third day of virtual.drupa, 22 April, features the keynote 'All change: Implications of the climate megatrend for the printing industry' by Gabrielle Walker, as part of the World Earth Day.

After the keynote opening each day, the conference programme continues with live lectures and panel discussions on five virtual stages. The topics explored at the drupa cube include artificial intelligence, sustainability, printed electronics and smart packaging. The schedule for the dna – drupa next age – offers, among others, two lectures on BigContentData, the project identifying new chances and approaches for print and media companies made possible through digitalisation, an introduction of the Print Your Future project aimed at attracting a new skilled workforce for quality jobs to the European graphical sector, co-coordinated by Intergraf, and the presentation of ColorNet, a novel software solution that utilises artificial intelligence to optimise the display of brand colours during live sporting events, which was developed at the Clemson University.

The calendar of events is still changing

Again, several events presented in the previous JPMTR issue had to be rescheduled, many events cancelled for 2021 at all. Now, some of the June events are planned to be held in a non-virtual format. That being possible would be great news.

FORUM 2021

https://www.flexography.org
11–14 & 18–21 May 2021

The programme of this year's FORUM of the Flexographic Technical Association offers more than 20 technical presentations and discussions in 9 sessions, with efficiency being the main focus. This time, also the INFOFLEX 2021 exhibition takes place as a virtual event on 12–13 & 18–20 May.

HOPV21
13th Conference on Hybrid and Organic Photovoltaics

http://www.nanoge.org
25 and 28 May 2021

This established event is held online for the second time, offering over 20 invited speakers and a scientific programme with oral and electronic poster presentations. In addition, a pre-conference workshop, Maestro Perovskite Research Seminar, can be attended on 24 May. Its topics are perovskite materials and devices, namely the single and multi-junction solar cells and light-emitting devices, and perovskite technology upscaling. Four weeks earlier, on 29–30 April, the conference on Organic Materials in Perovskite-Based Optoelectronic Devices is held, also online.

ESMA Events

Being still limited to the online activities, the European Specialist Printing Manufacturers Association offers during spring two online ESMA Academy courses on industrial digital printing – in German on 18–20 May and in English on 8–10 June 2021. Besides this established training, the ESMA experts are involved in the touchpoint textile at the virtual.drupa, presenting there. among others, the roadmap of textile printing with respect to the emergence of digital printing in various applications from soft-signage to sportswear and fast fashion to home textiles.

Understanding Inkjet Conference 2021

Appleton, Wisconsin, USA
8–9 June 2021

The focus of this IMI event is on the inkjet capabilities, applications, selection and implementation. The topics of its two-day schedule include the inkjet technology for production printing, inks, drying and curing technologies, software for print quality optimisation, media handling for the on-demand printing, new market opportunities beyond traditional printing, matching applications with the right inkjet technology, end users' views, and the real-world experiences with implementation.

The London Book Fair 2021

London, UK
29 June – 1 July 2021

In 2021, The London Book Fair celebrates its 50-year anniversary. Currently, the organisers are planning for all scenarios and working on robust measures being in place to stay safe if a face-to-face event will be permitted. The programme includes the Introduction to Rights conference, The Research & Scholarly Publishing Forum, What Works? Education Conference, and The Writers' Summit.

From the three touchpoint stages, over 20 sessions are dedicated to packaging, such as a panel discussion on the new opportunities in alternative channels and e-commerce for food brands and another one providing a design perspective on packaging sustainability. The latter topic is also covered in the lectures presenting some of the available solutions for reducing waste. The other packaging topics explore the development and growth of printing for smart packaging, applications of augmented reality, means to achieve the right colours, and more. Among over ten sessions at the touchpoint textile, one of the panel discussions deals with a future outlook for the Digital Textile Microfactory, a concept for the virtual development and digitally networked production of personalised textiles and clothes, which is discussed also in a number of other sessions. The touchpoint 3D fab+print includes about ten sessions dealing with 3D metal printing, material innovations, the monitoring system for the additive manufacturing process that employs artificial intelligence, and other topics.

Several sessions included in the programme of virtual.drupa are provided by VDMA, the German Engineering Federation. Their content mostly reflects the four main topics, presenting the networked production systems and connecting directly to the customer, the solutions enabled by artificial intelligence, the technology and approaches helping to increase sustainability, and more. The conference area of virtual.drupa also features the symposium, which is jointly organized by IC, the International Circle of Educational Institutes of Graphic-Media Technology and Management, iarigai, the International Association of Research Organizations for the Information, Media and Graphic Arts Industries, Hochschule der Medien, the University of Media Stuttgart, and HELGRAMED, the Hellenic Union of Graphic Arts and Media Technology Engineers, and presented in the following section.

Bridging Industry, Education and Research in Graphic Communication, Print and Media

The event is held on 21 April 2021 later in the afternoon and comprises five lectures highlighting the importance of the interaction among the print media industry, education and research. After the opening of the conference, the programme features Frank Romano with the lecture addressing the future of printing. The focus of the following presentations is on the next generations and education, with Beatrice Klose describing the need for a younger workforce and summarising the efforts to attract skilled people to work in the European printing industry, John R. Craft reviewing the innovative initiatives at university graphic communications degree programmes in the United States, Jan De Roeck providing the real-life examples of beneficial cooperation initiatives between industry technology supplier and educational institutions and their potential to drive overall innovation in the industry, and Jörg Hunsche presenting the topic of digital printing evolution and its opportunities to create added value when linked to the digital world being a living experience of young generations. The event concludes after the presentation of the iarigai and IC annual scientific conferences to be jointly held in September 2021 in Athens, Greece.

This virtual.drupa event is supported by Intergraf, the European federation for print and digital communication, GCEA, the Graphic Communications Educators Association, EGIN, the European Graphic-Media Industry Network, TAGA, the Technical Association of the Graphic Arts, and the WAN-IFRA's World Printers Forum.