

TOPICALITIES

Edited by Markéta Držková

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News & more

A selection of patents on printing inks granted during the last five years

When looking at the recent trends for patents dealing with inks, as covered in the Minesoft PatBase and categorized by the Cooperative Patent Classification (CPC) system, only a few categories show a clear decline in the number of published patents. Some maintain previous levels, while most categories exhibit an increase in granted patents. From the main groups, if omitting the writing inks, the electrically conductive inks remain steady after the earlier increase, and the sympathetic, colour-changing or similar inks, as well as the two-component inks, approximately doubled. For inkjet inks, the trends vary among specific types. The same applies to the largest group of general printing inks, which is the main focus of this overview. In this group, most of the few thousands of recent patents protect inventions related to printing inks based on artificial resins, and only a small fraction deals with inks based on natural resins. About a quarter of patents are related to radiation-curable inks; the share for the inks characterised by the pigment is also substantial. The following sections briefly present selected patents of the most active companies; other examples are provided in the side column.

Sun Chemical Corporation

Many recent Sun Chemical patents deal with packaging inks. For instance, US 11,034,850 B2 covers the multipurpose shrink-sleeve printing inks and coatings for flexography and gravure printing, offering resistance to chemicals, softening, re-wetting and set-off, US 11,591,482 B2 the water-based inks with alcohol tolerant latexes that are suitable for printing on plastic substrates, such as polypropylene, polyethylene terephthalate or polyamides, by different printing techniques, including high-speed flexography or gravure printing, US 11,697,742 B2 the solvent-based white ink with high opacity, which, besides TiO₂, contains polymeric void spherical particles, and US 11,753,556 B2 the utilisation of this concept in water-based inks that reduce wear of die-cutting blades. Among different examples for food packaging, US 11,236,243 B2 deals with the low-migration inks that can be cured using UV-LED technology even at high printing speeds, US 10,961,406 B2 with the ink composition resistant to smear and also heat, which makes it suitable for printing of packaging for food cooked in that packaging, and EP 3 931 273 B1 with the black solvent-based packaging ink safe for microwave use. Further, EP 3 322 762 B1 concerns the water-based printing inks for thermoforming applications and EP 3 894 487 B1 the heat-resistant paper-feel overprint varnishes applicable to foils for hot stamping or sealing. Several patents present solutions for plastics recycling, such as US 11,236,213 B2, dealing with the water-soluble or dispersible polyester resins made from polyethylene terephthalate waste and useful for inks, and EP 3 414 295 B1, describing the polystyrene with high molecular weight obtained by depolymerising a source polystyrene resin and applicable in inks and coatings.

DIC Corporation

The patents from the group of general printing inks granted during the last five years to this company, formerly named in full Dainippon Ink and Chemi-

More on the recent patents on printing inks

Among the printing formulations for radiation curing, US 10,731,045 B2 of 3M company presents the UV-curable flexographic ink with nanoparticles of inorganic oxides absorbing infrared radiation, US 11,441,042 B2 of Flexcon the enhanced product security labels based on a radiation-curable pressure-sensitive adhesive coating containing reflective particles creating a visually unique pattern, EP 3 555 216 B1 of Gleitsmann Security Inks the radiation-curing intaglio ink with high dispersibility in wiping solution and at the same time the desired chemical resistance, US 11,787,959 B2 of Changzhou Green Photosensitive Materials the radiation-curable gravure ink with improved storage stability and production efficiency, and US 11,840,644 B2 of Allnex the radiation-curable compositions for low-gloss coatings. This last-mentioned company also provides polyester (meth)acrylate resin based on recycled polyethylene terephthalate and suitable for inks and coatings formulations (US 11,267,949 B2).

Other examples of UV-curable compositions include the inks for direct-to-textile printing described in US 10,857,814 B2 by Direct Color and inkjet inks disclosed in EP 3 613 815 B1 of Canon Production Printing, formerly known as Océ. Other patents of Canon group, such as US 11,827,796 B2, deal with various radiation-curable materials for 3D printing. Several Canon patents are concerned with thermal-transfer technology; for example, US 11,801,703 B2 describes the heat-sensitive transfer recording sheet.

A different use of UV radiation is described in US 11,407,236 B2 by HP, where it is utilised to heat the printed layer to melt the thermoplastic resin particles. Various materials for electrophotography are provided in a

number of other HP patents, such as the polymer-encapsulated metallic ink particles in EP 3 137 562 B1. Similarly,

Fujifilm patents include, among others, US 11,781,044 B2 that deals with resin composites for pressure-sensitive adhesives or toners.

The recently patented compositions for packaging printing include the eco-friendly and non-toxic adhesion promoter for food packaging printing ink provided in US 10,259,953 B2 of Borica, the flexible laminate for retortable food packaging, digitally printed and cured using an electron beam, presented in US 11,376,831 B2 of Amcor, and the printing ink allowing to produce easily tearable laminate bag for storing food, described in US 10,577,513 B2 of Sakata Inx. Yet other application areas are covered by EP 3 353 248 B1 of Ferro, with the thermoplastic screen-printing paste for decorating glass, US 10,745,575 B2 of Eckart, presenting the metallic effect pigments with high specular gloss for offset printing inks, and US 11,325,368 B2 of Flint Group, providing the method for producing pictorial relief structures.

The coating compositions with fatty acid esters of vegetable origin as solvents are presented in EP 3 577 173 B1, assigned to the inventors based in Italy. Another example is the environmentally friendly combination of offset ink and fountain solution described in US 10,590,292 B2 of Sicpa. However, most patents of this company present security printing solutions, such as the magnetic machine-readable oxidatively drying intaglio inks in EP 3 408 337 B1 and oriented non-spherical magnetic or magnetisable pigment particles for optical effect layers in EP 3 849 711 B1.

Further examples from this area include the interference pigments in US 11,820,900 B2 of Merck and solutions of Giesecke+Devrient, e.g. the pigment fragments with specified contours in US 11,702,548 B2 or the lens pigment for security printing ink in US 11,618,276 B2. Numerous patents deal with materials for 3D or 4D printing, some of which were presented in this section in JPMTR Vol. 11 no. 1 (2022).

include several European patents. One example is EP 3 395 570 B1, which describes the manufacturing of laminate with desired gas-barrier properties. Other ones cover various aspects of ink formulations, from the curing accelerator for oxidation polymerisation in EP 3 020 766 B1 to the radiation-curable compositions exhibiting high curability and offset printability in EP 3 211 016 B1, up to producing the quinacridone and phthalocyanine pigment compositions in EP 3 323 858 B1 and EP 2 927 286 B1, respectively. The recent DIC patents also include those granted by patent offices in the United States, Australia, Taiwan, and China; however, the majority are Japanese patents. Many describe different pigment compositions and their applications. Among other examples, JP 6557799 B1 deals with the water-based flexographic ink for electron-beam curing, suitable for printing boilable and retort pouches, JP 6963013 B2 with the offset printing ink compositions drying by oxidative polymerisation and improving the set-off resistance of the printed matter, JP 7197054 B2 with the water-based ink forming a printed layer that can be later released using hot water or alkaline solution to facilitate recycling of the plastic substrate, and JP 7401025 B2 with the phthalocyanine pigments having antibacterial or antiviral effects.

Xerox Corporation

Most of the recent Xerox patents related to general printing inks were granted by the U.S., European and Korean patent offices, complemented by the Canadian and German ones. To illustrate the range of topics, US 10,358,563 B2 deals with the method for making a core-shell composite with silver nanoparticles in the shell layer, US 10,406,831 B2 with the system for printing and coating stretchable, radiation-curable inks on a thermoformable substrate, US 10,907,059 B2 with the water-based clear ink compositions for digital offset lithographic printing, and US 10,436,758 B2 with the method and apparatus for determining an ultraviolet cure level of 3D-printed material. Several patents present materials for various 3D printing techniques, such as the sustainable thermoplastic material derived from bio-based monomers, 3D-printable by fused deposition modelling, described in US 10,323,156 B2, the curable ink compositions suitable for multi-jet modelling in EP 3 309 225 B1, and the large spherical microparticles of crystalline polyester for selective laser sintering in EP 3 569 634 B1. Another group of Xerox patents concerns printing UV-curable materials to form multilayer structures to be transferred for various purposes. For example, US 10,286,689 B1 describes the process of making transferrable materials, applicable to different types of objects, using printing ink and primer layers, US 10,899,155 B2 presents printing ink and adhesive layers to produce retail signs that can be stacked without the need for a release liner between them, and EP 3 524 648 B1 provides a solution for transferring a printed, stretchable multilayer assembly onto curved surfaces.

BASF

Among the recent BASF patents classified in the general printing inks group, US 10,633,553 B2 describes the radiation-curable functional resins with high reactivity, EP 3 285 942 B1 the preparation of electrically non-conductive silver nanoparticle layers to enhance optical properties of security elements, EP 3 303 487 B1 the naphthalocyanine derivatives as almost colourless IR absorbers for security printing applications, and EP 3 523 303 B1 the novel 2-phenylphenoxy-substituted perylene bisimide compounds and their use in colour converters for light-emitting diodes or inks for security printing. In US 11,752,700 B2, BASF, jointly with the Massachusetts Institute of Technology, presents systems and methods for formulating the material in a data-driven manner to efficiently develop optimised materials, e.g. for 3D printing.

Bookshelf

Fundamentals and Applications of Colour Engineering

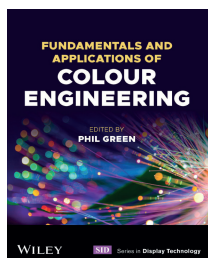
This volume is the most recent in the established Series in Display Technology Products. It comes about two decades after *Colour Engineering: Achieving Device Independent Colour*, published as the fourth one in the series.

The introductory notes of the book define the scope, explain the basic concepts, quantities and units related to colour, its recording and reproduction, and overview the main content organised into 20 chapters. The first two chapters provide the background on colorimetry. One deals with visual colorimetry and its simulation using analogue or digital measurement devices, including practical aspects like selecting and using colorimeters and spectrophotometers, understanding sources of error and uncertainty and geometric requirements when measuring the colour of self-luminous, reflecting or transmitting objects. The second one details the colorimetric definitions and calculations as well as different approaches to quantify colour difference and define tolerances.

The next five chapters are dedicated to the device characterisation needed to define the relationship between the colour reproduced by the device and the perceived colour to achieve a desired match. The text introduces the fundamentals, including test charts, calibration, linearisation, numerical models, look-up tables and training and test data for evaluating accuracy, and then describes the methods of characterising input devices, colour processing for digital cameras, display calibration and characterising hard copy printers. Also, it discusses specific considerations, e.g. for multi-frame processing, drift in display measurements, fluorescent whitening agents or spot colours.

Then, six chapters cover the exchange of colour information. First, the text discusses different colour encoding options and various aspects of colour gamut communication, from the factors affecting colour gamut to obtaining, analysing and visualising gamut information up to its encoding. Next, the basic concepts of colour management architecture developed by the International Color Consortium (ICC) are explained for both the ICC.1 and (the more recent) ICC.2 specifications. The latter version, denoted as the iccMAX colour management, includes extensions to architecture, profile format and data structure. In the book, it is presented by Max Derhak; for his related PhD thesis see also JPMTR Vol. 5, No 3 (2016). Further, the main forms of sensor adjustments and colour transform evaluation approaches are introduced.

The remaining chapters deal with the perception of gloss and translucency and their impact on colour technologies, colour management of material appearance, the evolution of colour definitions on the World Wide Web, the technologies and considerations for high dynamic range imaging and wide colour gamut displays, colour in augmented and virtual realities, and also several useful open source tools.



Editor: Phil Green

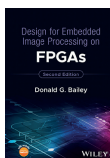
Publisher: Wiley
1st ed., October 2023
ISBN: 978-1-119-82718-4
400 pages
Hardcover
Available also as an eBook



Design for Embedded Image Processing on FPGAs

Author: Donald G. Bailey

Publisher: Wiley
2nd ed., August 2023
ISBN: 978-1119819790
496 pages
Hardcover
Also as an eBook



This volume briefly provides the background on image processing, hardware architecture and programming of field-programmable gate arrays (FPGAs). Then, it focuses on the use of these configurable integrated circuits in image processing, from the design process and constraints, computational techniques and interfacing to point and histogram operations, local filters, geometric transformations, linear transforms, image and video coding, blob detection and labelling, up to machine learning and example applications, e.g. for stereo imaging or face detection. The new edition reflects the increasing resolutions, frame rates and bit depths, as well as the improved capabilities and reduced power requirements of FPGAs.

Document Layout Analysis

Author: Showmik Bhowmik

Publisher: Springer
1st ed., August 2023
ISBN: 978-9819942763
94 pages, 1 image
Softcover
Also as an eBook

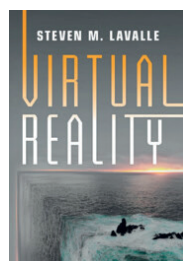


This concise book is published in the SpringerBriefs in Computer Science series and presents the fundamentals of document layout analysis, such as its aims and stages, as well as recent advancements and research trends in this area that reflect the need to achieve proper recognition of individual elements and structure of different digitised documents despite their increasing variety and complexity. It discusses methods for image binarisation, region segmentation and region classification and presents two case studies.

Virtual Reality

Drawing on his broad experience with teaching and research in the fields of robotics and, more recently, virtual reality (VR), including the development at Oculus VR, the author offers a comprehensive but accessible introduction to all key aspects of the topic. Besides this published book, a full draft and additional materials are available online.

The book begins with a definition of virtual reality, an explanation of related terms and a historical context, followed by an overview of hardware and software components of VR systems and the key aspects of human physiology and perception that are critical for the successful development of VR technology. The subsequent chapters detail the geometry of virtual worlds with models and transformations, light and optics, the physiology of human vision, visual perception and rendering. Further, the book deals with motion in real and virtual worlds, tracking and interaction. Also, it covers the audio component. Finally, it discusses the approaches helpful in evaluating VR systems and experiences, typical issues encountered today as well as those expected in the future together with recommendations for developers, comfort and VR sickness, experiments on human subjects and the future directions of VR development, including the technology for touch, smell and taste sensation on the one hand and robotic and brain-machine interfaces on the other hand.



Author: Steven M. LaValle

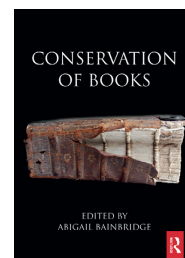
Publisher: Cambridge University Press
1st ed., November 2023
ISBN: 978-1-107-19893-7
392 pages
Hardcover
Available also as an eBook

Conservation of Books

This volume presents comprehensive coverage of the topic by 70 contributors from across the globe. The content is organised into five sections. The first and most extensive one provides an overview of book structures and history. It begins with the emergence of codices and continues with the chapters describing bindings of the Eastern Mediterranean, South, East and South-east Asia, Europe, and North and Latin America, but not necessarily limited to individual territories. The second section details bookbinding materials and their degradation, from papyrus to polymers. The remaining three sections present the approaches to conservation, methods of preventive conservation, including digitisation, and interventive conservation techniques.

Editor: Abigail Bainbridge

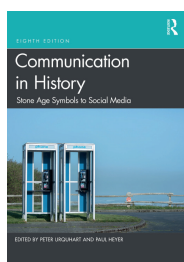
Publisher: Routledge
1st ed., March 2023
ISBN: 978-0-367-75490-7
734 pages, 139 images
Hardcover
Available also as an eBook



Communication in History Stone Age Symbols to Social Media

The first edition of this book was published in 1991 with the subtitle Technology, Culture, Society and edited by D. J. Crowley and P. Heyer. Although the coverage has grown over the years both towards new technology and phenomena and new perspectives on media history, the focus on the uses and consequences of communication media concerning the development of human behaviour and social experience remains unchanged.

This edition features 34 essays organised into seven parts, each beginning with an introductory overview. The content is complemented with questions and suggested readings to support further study and discussion. Two parts deal with the media of early civilisation up to the origins of writing and the tradition of Western literacy. The third part is dedicated to the print revolution. It presents the inventions of paper, block printing, and printing from movable types, as well as the roles of early-modern literacy and print, including sensationalism in early forms of printed news. Three parts describe the evolution of communication technology and the communicated content. The last part discusses media in the digital age, tracking the intertwined development of mass media and data processing, access to the Internet, remediating the content through the World Wide Web and the cultural history of Web 2.0. Also, it discusses the serious concerns connected to social media and big data.



Editors: Peter Urquhart, Paul Heyer

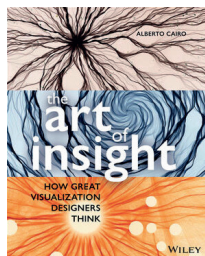
Publisher: Routledge
8th ed., January 2024
ISBN: 978-1-03-216829-6
300 pages, 26 images
Hardcover
Available also as an eBook

The Art of Insight How Great Visualization Designers Think

Readers of this book can learn more about the design process through an in-depth exploration of how over 20 designers with diverse backgrounds make design choices when analysing data, research findings or stories and options for sharing the revealed message. The text discusses selected infographics and data visualisation projects in terms of aesthetics, ethics, impact and more. The book's chapters are grouped into four parts: Pragmatists, Eccentrics, Ambassadors and Narrators. The themes range from global warming to art and from hobbies to investigation and war journalism.

Author: Alberto Cairo

Publisher: Wiley
1st ed., November 2023
ISBN: 978-1-119-79739-5
320 pages
Softcover
Available also as an eBook



Perspectives on Design and Digital Communication IV Research, Innovations and Best Practices

*Editors: Nuno Martins, Daniel Brandão,
Adérito Fernandes-Marcos*



Publisher: Springer
1st ed., September 2023
ISBN: 978-3031417696
387 pages, 89 images
Hardcover
Also as an eBook

This volume is contributed by the authors of the best papers presented at Digicom 2022 (for the proceedings, see also this section in JPMTR Vol. 12, No. 4) and other invited experts. The topics include, among others, user experience design for privacy in instant messaging applications, the impact of visual design on public participation, design and usability of university digital repositories, design culture perception, text-to-image artificial intelligence, creative digital advertising, the types of endogenous asymmetry in games contributing to a unique gameplay experience, and no-code augmented reality tools.

ADA in Details Interpreting the 2010 Americans with Disabilities Act Standards for Accessible Design

Author: Janis Kent



Publisher: Wiley
2nd ed., August 2023
ISBN: 978-1119900245
512 pages
Softcover
Also as an eBook

While most of the approaches in this volume are particularly relevant for civil engineering, the author also covers the design for those suffering from colour vision deficiency or autism spectrum disorder and related considerations. One chapter deals with individual communication elements, including various types of signs, their components, visual or tactile representation, suitable location, common pictograms and internationally recognised symbols.

Shape Memory Polymer-Derived Nanocomposites Materials, Properties, and Applications

Author: Ayesha Kausar

Publisher: Elsevier
1st ed., January 2024
ISBN: 978-0443185045
316 pages
Softcover
Also as an eBook

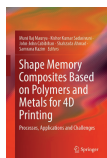


This book reviews the progress achieved thanks to shape-memory polymers enhanced with nanofillers. It presents nanocomposites with polyurethane, epoxy, polyester, polystyrene or polyisoprene matrices and applications of shape-memory nanocomposites as sponges, materials for aerospace, shielding of electromagnetic interference or ionising radiation, electronics, smart textiles and in biomedical applications. It concludes with modelling and simulating shape-memory nanocomposites, the role of 3D and 4D printing and sustainability and environmental concerns.

Shape Memory Composites Based on Polymers and Metals for 4D Printing Processes, Applications and Challenges

Editors: Muni R. Maurya, Kishor K. Sadasivuni, John-John Cabibihan, Shahzada Ahmad, Samrana Kazim

Publisher: Springer
1st ed., May 2022
ISBN: 978-3030941130
431 pages, 171 images
Hardcover
Also as an eBook



About 50 contributors of this volume provide insight into the advances in 4D printing of shape-memory materials in terms of their composition, size and form of filler material, resulting composite structure, properties and behaviour, different simulation, characterisation and synthesis methods, developments in printing techniques, novel applications and known challenges.

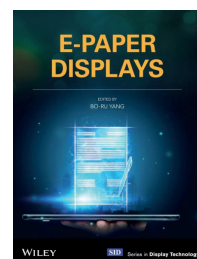
E-Paper Displays

Electronic paper technologies belong to those promising for the Internet of Things and other applications that require displays with minimum power consumption, good readability in ambient light, flexibility and low fabrication costs. This volume reviews a wide range of paper-like display technologies, from pioneering inventions to emerging solutions, providing insight into their working principles, technical parameters, engineering considerations, fabrication options, user acceptance and business potential. Approximately 20 experts have contributed to covering all aspects discussed.

The introductory chapter describes the first approaches towards a display with qualities close to the print on paper and the evolution of electrophoretic display-based electronic paper. The following three chapters detail fundamental mechanisms, driving waveforms and image processing methods for electrophoretic displays, together with their enhancement by the CLEARink technology. Then, four chapters deal with the bistable cholesteric liquid crystal displays, including the zenithal bistable display with a relief grating as one of the liquid crystal alignment surfaces, Memory-in-Pixel and optically rewritable liquid crystal displays. Further, electrowetting, electrochromic and phase-change material displays are presented. The last chapter discusses the reflective optical measurements for an objective evaluation of electronic paper display quality.

Editor: Bo-Ru Yang

Publisher: Wiley
1st ed., August 2022
ISBN: 978-1-119-74558-7
320 pages
Hardcover
Available also as an eBook

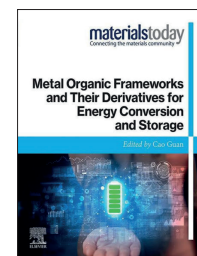


Metal Organic Frameworks and Their Derivatives for Energy Conversion and Storage

This volume, with over 40 contributors, provides a reference on this emerging field. First, it explains the designing principle and synthesis methods of metal-organic frameworks. It covers their main types, including bimetallic, multimetallic, carbonaceous and metal compound materials, and structures, such as nanoarrays, nanowires, and hollow metal-organic frameworks. Further, it presents applications for electrocatalysis, fuel cells, metal-air batteries, battery electrodes, supercapacitors and separators. It also covers their fabrication through inkjet printing, digital light processing, stereolithography, direct ink writing, fused deposition modelling and selective laser sintering.

Editor: Cao Guan

Publisher: Elsevier
1st ed., January 2024
ISBN: 978-0-443-18847-3
422 pages
Softcover
Available also as an eBook



Bookshelf

Academic dissertations

Inter-Layer Adhesion in Material Extrusion 3D Printing: Effect of Processing and Molecular Variables

While fused deposition modelling has become a widespread 3D printing technique, the insufficient adhesion between individual adjacent layers still belongs to the substantial factors limiting its use in some applications and complicating the selection of a suitable material. This thesis aimed to gain insight into the relationship between different characteristics of polymer materials with resulting inter-layer bond quality and mechanical properties. The research comprised systematic studies of a range of materials using different methods, including sophisticated ones. Also, it proposed the approach to follow the extent of crystallisation of 3D-printed polymers in situ by means of a feasible light-scattering setup.

The dissertation provides the background on additive manufacturing with a focus on fused deposition modelling, current knowledge of mechanical anisotropy and inter-layer bond formation, and literature on in-situ crystallisation measurements. After the overview of all studied materials and methods used for their 3D printing and characterisation, four chapters detail the effects of residual orientation, molecular weight, chain rigidity and crystallisation on weld strength. It was shown that residual orientation occurs in the weld regions between printed filaments and contributes to reduced weld strength. Stronger welds can be achieved by increasing the nozzle temperature and decreasing print speed. One of the key findings is that the lower molecular weight of the printed material helps decrease anisotropy at the weld region and thus improves the inter-layer adhesion, contrary to the effect in the case of other processing methods, such as compression moulding. Further results suggest that residual anisotropy is also reduced with increasing chain stiffness and document the influence of printing speed on crystallinity and weld strength for two different semicrystalline polymers. Finally, the work presents the differences between the scattered light patterns and their temporal evolution when printing amorphous and semicrystalline materials.

Doctoral thesis – Summary

Author:
Andrea Costanzo

Speciality field:
Materials Science and Technology

Supervisor:
Dario Cavallo

Defended:
*17 March 2023,
University of Genoa, Department of
Chemistry and Industrial Chemistry
Genoa, Italy*

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Further reading:
<https://hdl.handle.net/11567/1108459>

3D Printing of Green Water Purification Filters: Design Towards Sustainable and Scalable Biocomposite Materials

This thesis explored the possibility of using the fused deposition modelling technology to produce purification filters capable of removing various contaminants from water. The primary objectives were to develop composites based on renewable materials or recycled waste to be printable by commercial 3D printers and design filters with properties allowing implementation in the water treatment industry, especially with sufficient structural stability and appropriate mechanical properties. The work studied composites with either polylactic acid (PLA) or polyethylene terephthalate glycol (PETG) matrix. The former polymer was combined with three different hydrophilic materials: hydroxyapatite powder from fish scales, chitin nanofibres and cellulose nanofibres oxidised by (2,2,6,6-tetramethylpiperidin-1-yl)oxyl (TEMPO); in addition, the last composite was further activated and functionalised with bioinspired metal-organic framework synthesised from nonhazardous materials. For the latter matrix, a functional component was prepared using

Doctoral thesis – Summary

Author:
Natalia Fijoł

Speciality field:
Materials Chemistry

Supervisors:
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Lennart Bergström*

Defended:
*22 September 2023, Stockholm
University, Department of Materials
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Further reading:
ISBN: 978-91-8014-417-9

TEMPO-mediated oxidation of the post-consumer polycotton textile waste. The experimental work included testing the homogeneity and printability of composites, as well as the performance, mechanical stability, durability and biodegradability of resulting water purification filters.

Two chapters of the dissertation introduce the main concepts, individual types of materials and methods for their preparation and processing and provide all experimental details, including characterisation methods and functionality tests. Three chapters then describe developing composites for 3D printing, including a thorough characterisation in all processing steps, optimising and evaluating the performance of 3D-printed water purification filters and estimating their lifespan via accelerated ageing experiments. The preparation of PLA composite filaments made use of thermally induced phase separation to obtain a homogenous dispersion of nanoparticles. For PETG composites, cast films of chemically treated polycotton were cut and directly extruded. When tested with metal ions in model solutions or mine effluent, microplastics in laundry effluent and cationic dye solution, the prepared filters reached separation efficiencies mostly about 40 to 60 %, depending on their composition, geometry, porosity and other conditions.

Doctoral thesis – Summary

Author:
Pascal Kiefer

Speciality field:
Materials Systems Engineering

Supervisors:
Martin Wegener
Martin Bastmeyer

Defended:
8 December 2023,
Karlsruhe Institute of Technology,
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Karlsruhe, Germany

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Further reading:
DOI: 10.5445/IR/1000167180

On Next-Generation Multi-Focus 3D Laser Printing

The research within this thesis focused on increasing the printing rate of 3D printing based on solidifying a liquid photoresist at the micro- and nanoscale by pulsed laser radiation, a technique which is called multi-photon 3D laser printing or direct laser writing. The work builds upon the approach that overcomes the limitations of laser scanning speed using nine laser foci in a 3×3 matrix. A further increase in the printing rate by simply increasing the number of foci is limited by the energy required for curing and the damage threshold of the optical components. The solution to reach an order of magnitude higher peak printing rates is based on a novel photoinitiator enhancing the photoresist sensitivity and high-quality micro-optical components for a hybrid diffractive-refractive beam-splitting method.

The dissertation brings a comprehensive account of the topic. One chapter reviews the fundamentals of 3D laser printing, from a photopolymerisation to the two-photon exposure dose with theoretical assumptions and simulations, up to power scaling considerations in terms of photoresist nonlinearity, parallelisation and dynamic or static beam splitting. Also, it compares the printing speeds of different 3D printing technologies. The next one details the experimental methods and materials. Then, three chapters present the main steps of development. For highly sensitive photoresists, a figure of merit considering different parameters was introduced to reasonably compare photoresist sensitivities, enabling the definition of the target value and selection systems for further investigation. While the enhancement achieved with additional photoinitiators or co-initiators was insufficient, the required sensitivity at higher scan speeds was provided by a newly synthesised benzylidene-ketone derivative with high solubility. To optimise beam-splitting, the hybrid diffractive-refractive beam-splitting approach was chosen and the design and fabrication of micro-optical components were improved to achieve the desired optical quality. The progress accomplished in both aspects enabled the design of a high-speed multi-focus 3D laser printer. The work describes the optical setup and its experimental characterisation; the mean voxel size achieved in printing tests was about 690 nm. Finally, one chapter demonstrates multi-focus manufacturing of large-scale microstructures with applications in drug delivery, metamaterials and particle physics.

Events

SPIE events

SPIE Photonics Europe 2024

SPIE. PHOTONICS
EUROPE Strasbourg, France
7–11 April 2024

In 2024, this cross-disciplinary optics and photonics event features the fourth edition of conferences on 3D-printed optics and additive photonic manufacturing and fundamentals and devices in organic electronics and photonics. The programme of the other conferences includes, for example, the invited paper on all-printed multisource energy harvesters.

SPIE Defense + Commercial Sensing 2024

SPIE. DEFENSE+
COMMERCIAL
SENSING National Harbor, Maryland, USA
21–25 April 2024


This SPIE event also offers several printing-related contributions, such as the sensors for surface-enhanced Raman scattering for the detection of chemical warfare agents and environmental pollutants printed by aerosol jet, the 3D-printed flexible sensing devices for security applications, the inkjet-printed 2D conductors for electromyography electrodes, or the papers dealing with 3D-printed fibre-reinforced composite materials in terms of in-line monitoring of their fabrication process and the non-destructive evaluation of mechanical behaviour.

9th Conference on Information and Graphic Arts Technology

 9th Conference
Information and Graphic Arts Technology Ljubljana, Slovenia
11–12 April 2024

This conference, held at the University of Ljubljana, Faculty of Natural Sciences and Engineering, returns under the auspices of the Ghent Workgroup. Besides its co-located technical meeting, GWG members present a technological forum on the future of PDF for the Ljubljana University students before the event and also actively participate in the conference programme, discussing the state and future of print technology and processes, preflight, PDF 2.0 format and the corresponding PDF/X-6 standard.

Forum & INFOFLEX 2024

 FORUM
2024 Kansas City, Missouri, USA
5–8 May 2024

This year, the Flexographic Technical Association's Forum sessions focus on the packaging-related challenges of brand owners, quality improvement in the pressroom, issues, current technologies, colour management, workflow, printing materials trends, Flexo Quality Consortium projects, and more.

Reconnaissance events



In the second quarter of this year, the biannual Optical & Digital Document Security

conference takes place in Lisbon, Portugal (8–10 April 2024), with many seminars and presentations focused on artificial intelligence and quantum computing and their possible implications in the field, followed later by the High Security Printing Latin America conference in Santiago, Chile (3–5 June 2024).

ESMA Academy Functional Printing



Bremen, Germany
9–11 April 2024

This course is dedicated to screen printing of electrically conductive structures, covering both the printing process and required materials.

Archiving 2024

Washington, DC, USA
9–12 April 2024



This year's programme features a

keynote by Santiago Lyon, introducing the Content Authenticity Initiative, and much more. All presented papers are published Open Access.

Innovations in Publishing, Printing and Multimedia Technologies 2024



Kaunas, Lithuania
24–25 April 2024

This conference, covering a wide range of both scientific and practical aspects of media and printing, is held at Kauno kolegija Higher Education Institution, again in a hybrid mode.

TAPPICon 2024

Cleveland, Ohio, USA
28 April to 1 May 2024

This large event for the paper industry covers the topics related to barrier coatings, including their evaluation and formulation to prevent fold cracking, the effects of digital printing, and many others.

**Digital Publishing Summit 2024**

Paris, France
31 May 2024

The sessions of this event, hosted by the European Digital Reading Lab, deal with technical aspects, such as accessibility, new platforms, and artificial intelligence tools, as well as several digital publishing projects, especially the European ones.

**Print Matters 2024**

Bucharest, Romania
14 June 2024

The topics for this event held by Intergraf with the Nordic Printing Association include the Romanian graphic industry and drupa reviews, printing and packaging case studies, impacts of artificial intelligence on the print industry, recent research on reading and print and digital communication comparison, sustainability reporting, deforestation and distribution issues.

**London Imaging Meeting 2024**

London, UK
26–28 June 2024

This edition offers material appearance courses on the first day and a two-day technical programme featuring, for example, the keynote by Jon Y. Hardeberg.

**HOPV24****16th International Conference on Hybrid and Organic Photovoltaics**

Valencia, Spain
13–15 May 2024



For this edition, the schedule for each day begins with a plenary session, continues with two sessions in four parallel tracks, and ends with a special session. The first special session is in honour of Prof. Michael Graetzel with his talk at the end, the second focuses on energy policy and diplomacy, and the third is dedicated to raising the new generation of scientists in the field.

The programme on the first day is concerned with emerging materials and technologies. The topics of plenary lectures discuss, for example, the degradation mechanisms of bulk heterojunction organic solar cells and the possibilities to tailor structural and material properties of hybrid organic-inorganic perovskites through chirality and symmetry breaking introduced by the organic cation. Other sessions deal with material design and modelling, approaches to improve efficiency and stability, and emerging photovoltaics. The main focus of the second and third days is on organic and hybrid photovoltaics, respectively, covering the advanced characterisation and automation, development towards commercialisation and applications, device physics and engineering, novel materials and concepts. One track on the last day is reserved for industry talks and networking.

drupa 2024

Düsseldorf, Germany
28 May to 7 June 2024

After eight long years, the drupa fair is expected to highlight the progress in printing technologies and the key trends. Looking at the product categories, those for prepress and print, post-press, converting and packaging, materials, and equipment, services and infrastructure feature several hundreds of exhibitors each; however, even the less numerous categories for pre-media and multichannel publishing and future technologies offer tens of exhibitors. The latter category comprises solutions for Industry 4.0, inspection and testing, organic and printed electronics, 3D printing, nanotechnology, and research and development.

The 2024 edition includes the drupa touchpoints for packaging, textiles and sustainability. The programme at the drupa cube features five keynote speakers, sharing their expertise in various areas, from marketing to environmental issues to digital innovations, and the sessions named Business Boosters, Circular Economy and Sustainability, Print and Packaging Futures, and Trends; in addition, the Print & Digital Convention talks are scheduled on 2 June (in German). The topics discussed at the drupa next age (dna) special forum range from digitalisation, personalisation, e-commerce and solutions based on artificial intelligence, to the latest technology and novel measurement methods, up to the database and calculator of carbon emissions for the packaging and print sector and the future of print-media education. The visitors of drupa also can get in touch with the organisations dedicated to research, development and education in the field, including Fogra, CIP4, the International Circle of Educational Institutes for Graphic Media Technology and Management, and the iarigai association, the publisher of this journal.