

# TOPICALITIES

*Edited by Markéta Držková*

## CONTENTS

News & more	257
Bookshelf	259
Events	265



# News & more

## A yearly update on CIE publications



Among the publications from the International Commission on Illumination (CIE) issued since the previous overview provided in JPMTR 8(2019)4, the full papers of the presentations from the three-day technical conference held in June 2019 in Washington, DC, USA are collected in Volume 1 of the Proceedings of the 29<sup>th</sup> Session of the CIE (CIE x046:2019), comprising the majority of over 1 900 pages the proceedings have in total. Volume 2 with the quadrennial officers' and technical reports, as well as the reports on workshops, is freely available on the CIE website.

The new technical reports include CIE 236:2019, published at the end of 2019 and providing a summary of empirical data on lighting for pedestrians as a basis for future revisions to lighting design standards, CIE 238:2020 dealing with optical measurement methods, instrumentation and procedures to reproducibly characterise AC-driven light-emitting diodes for solid-state lighting applications thanks to accurately set and controlled junction temperature, and CIE 241:2020, which provides CIE recommended reference solar spectra for industrial applications (this document cancels and replaces CIE 085:1989). To facilitate systematic investigations of responses to light influenced by ipRGC (intrinsically-photosensitive retinal ganglion cells), CIE prepared freely available technical note CIE TN011:2020 with the guidance what to document and report in studies on this topic.

In reaction to COVID-19 pandemic, CIE made temporarily available for free two of its relevant documents: CIE 155:2003 Ultraviolet air disinfection and CIE 187:2010 UV-C photocarcinogenesis risks from germicidal lamps, downloaded by more than 14 thousand users. Also, the Russian translation of the latter publication was issued. Now, the content of these publications is summarised in the new CIE Position Statement on the use of ultraviolet radiation to manage the risk of COVID-19 transmission, explaining the most important aspects of the use of UV-C radiation (100–280 nm). While UV-C is highly effective in disinfection and sterilisation, it can be very hazardous to humans and animals as well as to cause photodegradation of the exposed materials. On the other hand, UV-C products that are safe for general use may not be effective in reducing the risk of virus transmission.

In cooperation with the International Organization for Standardization, namely with its technical committee ISO/TC 274 Light and lighting, CIE works on the revision of ISO 11664-2:2007 (CIE S 014-2:2006) to be released as the first edition of ISO/CIE 11664-2 Colorimetry – Part 2: CIE standard illuminants. The document defines the CIE standard illuminants A, D65 and D50 along with the sources for realizing these three illuminants. It also provides the appropriate theoretical and experimental basis and correlated colour temperatures for both daylight illuminants. The illuminants' relative spectral power distributions are included in Annex, with values at 1 nm intervals from 300 nm to 830 nm.

The sections on the next page present the publications that are more of interest to the field of print and media technology.

## Research and other activities of Fogra in 2020



From the areas covered by Fogra, almost half of projects in the 2020

research programme were concerned with prepress technology. The project investigating the possibilities for improving the readability of barcodes and matrix codes with regard to high-speed inkjet printing ended in spring. According to the results, the best performance was achieved with the barcodes aligned parallel to the print head and output in true black; the quality was also influenced by the bar width reduction. A tool developed for the corresponding PDF data verification is available free of charge within Callas software pdfToolbox. The agreement between the reading devices decreased with lower-quality codes. Recently has been finished the project focused on a colour-accurate soft proof for 3D objects, which involved characterisation of the process to acquire the material data, development of the rendering algorithm and integration of both into the iccMAX- framework.

The area of full-colour 3D printing is further explored in an ongoing project aiming to significantly streamline the characterisation and profiling processes thanks to the optical characterisation of the components produced by Polyjet and Multijet fusion technology. Another ongoing prepress project deals with colour communication in multi-primary printing. The new project running since June 2020 in cooperation with the Institute of Imaging & Computer Vision at the Aachen University aims to utilise machine learning for dynamic evaluation of image style, helping to select images suitable for a given purpose. The second project that started this year is also related to prepress technology; its goal is to design a standardisation concept to improve colour communication in digital textile printing.

In other areas of research, the topics currently studied at Fogra cover the classification of papers for high-speed inkjet printing, modelling of changes in colour appearance due to both matt and gloss coatings of known thickness, and improved bending analysis of smart cards for better predictability of their service life.

Among the recently finished Fogra projects, three comprised the research on characterisation and testing. The two lasting till spring 2020 include further development of the laboratory method for the determination of the residual strength of papers for heat-set web-offset printing, in order to meet the current conditions of print production, and the new test system for the evaluation of wettability and surface purity, which is based on two ink sets intended for surfaces that are predominantly either polar or non-polar and a so-called master ink to determine which set to use. This project also involved the development of a standardised method for ink application and software-supported evaluation procedure. The third one, finished this autumn, aimed to develop a method for characterisation of metallic prints. To establish objective parameters that correlate with their visual appearance, the work included the colour and gloss measurements of metallised print samples together with the development of a viewing technique allowing a clear assessment of the metallic effect. The last project that ended in the past months was carried at the Materials & Environment department of Fogra. It was dealing with a printable primer system for direct printing on glass, in particular on reusable beverage bottles, with the aim to achieve optimum adhesion both to the substrate and the UV-curing inks, and thus sufficient durability of the print.

During the past year, Fogra has also started the new one-year Fogra Web Academy as an additional option to the established on-site training courses. The one-hour online webinars in English are offered on Mondays since September 2020 and include 15 sessions, with each of them covering one fundamental topic and one special topic.

### **CIE S 017/E:2020 – ILV: International Lighting Vocabulary**

This is the 2<sup>nd</sup> edition of the International Lighting Vocabulary published as a CIE standard. This version cancels and replaces CIE S 017/E:2011 and CIE S 017-SP1/E:2015. The vocabulary, which was first published in 1938, provides the definitions and essential explanations for radiation, quantities and units, vision, colour rendering, colorimetry, emission, optical properties of materials, physical detectors for radiometric, photometric and colorimetric measurements, actinic effects of optical radiation, light sources, components of electric light sources and auxiliary apparatus, lighting technology and daylighting, luminaires and their components, visual signalling, and imaging. The online version of the vocabulary is available on the CIE website. Since 2015, all activities regarding the ILV are coordinated by CIE Divisions 1–6 and 8, as well as their harmonisation with IEC 60050-845 International Electrotechnical Vocabulary – Lighting and ISO 80000-7 Quantities and units – Part 7: Light and radiation. The new ILV from December 2020 comprises 248 pages and presents the definitions of 1 347 terms.

### **CIE 237:2020 – Non-linearity of optical detector systems**

This technical report prepared under Division 2, Physical Measurement of Light and Radiation, reviews the reasons for non-linearity of detectors, their operating circuits, measurement conditions, detector signal measurement modes and preamplifier output measurements. It also covers the non-linearity of detector arrays and avalanche photodiodes. The last part discusses the methods and approaches for the determination of linearity.

### **CIE 239:2020 – Goniospectroradiometry of optical radiation sources**

Another technical report elaborated under Division 2 deals with the measurement of the spectral distribution as a function of the emission angle of the source. It describes conditions, equipment and methods for goniospectroradiometric measurement, calculation of radiometric, photometric and colorimetric quantities, calibration, and measurement uncertainties.

### **CIE 240:2020 – Enhancement of images for colour-deficient observers**

Prepared by the appointed committee under Division 1, Vision and Colour, this technical report summarises on over 60 pages the methods used to enhance images to be easily recognised by colour-deficient observers. The document presents use cases and their requirements for image enhancement for colour-deficient observers and details the enhancement techniques based on recolouring, edge enhancement and pattern superposition, along with their comparison. It also provides three types of images (a natural image, a scientific visualisation and an office document) for testing of the enhancement techniques and describes different evaluation methods. The annexes include assessment and groups of colour-deficient observers, colour-difference metric and a glossary with the relevant terms.

### **CIE 242:2020 – Photometry of curved and flexible OLED and LED sources**

This technical report from Division 2 reflects the progress in the field of flexible products and describes the methods of measuring photometric and colorimetric quantities for curved sources, including luminance, luminous flux, colour, reflectance and viewing angle.

# Bookshelf

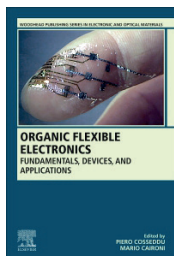
## Organic Flexible Electronics Fundamentals, Devices, and Applications

This new book with 70 contributors aims to bring a comprehensive and timely review in the field, from basic concepts of organic electronics to novel approaches to the design and fabrication of different electronic devices making use of new materials, technologies and architectures. The volume also presents a number of innovative and promising applications of flexible organic electronics.

The first chapter introduces the fundamentals of organic electronic devices, such as the charge-carrier transport and metal–semiconductor interfaces, and presents the main differences between organic and inorganic electronics. The next eight chapters deal with the materials for flexible organic electronics and their properties, detailing the development of conjugated polymers, electronic and ionic transport, chemical doping, interface energetics in organic electronic devices, thermoelectric and mechanical properties, as well as the encapsulation of flexible devices employing suitable barrier structures to ensure the long-term stability.

The next part explores the advances in flexible organic devices, namely the most significant achievements in the inkjet-printed organic and perovskite solar cells together with the remaining challenges for inkjet fabrication of active layers and electrodes, the thermoelectric generators for the energy harvesting of waste heat, the materials and designs of flexible alkali-ion batteries, the progress in 3D integration of organic printed transistors and circuits with a focus on modelling and simulations for their development, the amplifier topologies employing organic thin-film transistors including both unipolar and complementary solutions, the ultra-conformable organic devices for different purposes, and the stretchable electrodes for highly flexible electronics.

Finally, among the novel applications, one chapter discusses the organic biosensors and bioelectronics, especially the biosensors based on electrolyte-gated organic transistors, their mechanism and specific applications such as the detection of proteins. Another one presents the use of flexible organic electronics for the development of neuromorphic computing systems, mimicking and implementing essential concepts of the brain in hardware. Also here, in a future outlook, a particular focus is on interfacing with biological environments. The next chapter is dedicated to the emerging technology of flexible and large-area imagers using solution-processed organic photodetectors, including the recent developments towards the curved X-ray detectors and biometric scanners. The last chapter reviews the progress in the area of organic, flexible and wearable monitoring systems for biomedical applications, presenting the most interesting devices and systems in biomechanics, clinical electrophysiology and bioelectronics, which can be more easily and possibly imperceptibly integrated directly onto a human body.



*Editors: Piero Cosseddu, Mario Caironi*

Publisher: Woodhead Publishing

1<sup>st</sup> ed., October 2020

ISBN: 978-0-12-818890-3

664 pages

Softcover

Available also as an eBook





### Discrete Wavelet Transformations An Elementary Approach with Applications

Author: Patrick J. Van Fleet

Publisher: Wiley  
2<sup>nd</sup> ed., April 2019  
ISBN: 978-1118979273  
624 pages  
Hardcover  
Also as an eBook



The changes in the second edition of this textbook are based on the feedback received for the original one. After introducing wavelets and providing the basics of vectors, matrices and digital images, the text explains the Haar and Daubechies wavelet transformations, wavelet shrinkage and its application to signal denoising, biorthogonal wavelet transformations, complex numbers and Fourier series, filter construction in the Fourier domain, wavelet packets, lifting, and the JPEG2000 image compression standard. The book includes numerous exercises and basic statistics in the appendix.

### Handbook of Multimedia Information Security Techniques and Applications

Editors: Amit Kumar Singh,  
Anand Mohan

Publisher: Springer  
1<sup>st</sup> ed., August 2019  
ISBN: 978-3030158866  
808 pages, 369 images  
Hardcover  
Also as an eBook



The content of this book is organised into three parts that review the topics in multimedia security, processing and applications. Several chapters deal with biometrics, encryption and watermarking methods, image processing techniques for various purposes and the use of multimedia in medicine and the Internet-of-Things. The book also presents the face identification system, analysis of streaming data, digital image forensics with the methods for forgery detection, and more.

### Pioneers of Color Science

This book presents the history of colour science through brief descriptions of lives and scientific work of almost hundred pioneering figures in the field, having background mainly in physics or psychology, but also in chemistry, mathematics, optical engineering, physiology and art. The content is organised chronologically into five parts, dedicated to the era of antiquity, the Islamic Golden Age, the Middle Ages and the Renaissance, the Age of Enlightenment, and the period from the 19<sup>th</sup> century to present. The last part comprises about two-thirds of all essays. The span illustrates the collage by the first author, beginning with a part of the painting 'School of Athens' by Raphael depicting the antique philosophers with Plato and Aristotle at the centre, and ending with the photograph of David L. MacAdam and Gunter Wyszecki (with Ernst Ganz and Alan R. Robertson who are not presented in the book) taken by Fred W. Billmeyer at a CIE Meeting, which is merged with the CIE chromaticity diagram. The text includes several contributions from other authors, which were modified for this book after being published in the first edition of the Encyclopedia of Color Science and Technology, see this section in JPMTR 5(2016)3, or which are planned to appear in the second edition of the encyclopedia.



Authors: Renzo Shamey, Rolf Kuehni

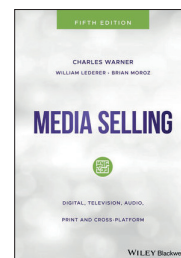
Publisher: Springer  
1<sup>st</sup> ed., November 2020  
ISBN: 978-3-319-30809-8  
431 pages, 198 images  
Hardcover  
Available also as an eBook

### Media Selling Digital, Television, Audio, Print and Cross-Platform

The current edition of this classic textbook on media selling by Ch. Warner has been thoroughly updated to reflect the vast changes in the media and advertising that took place since the fourth edition published a decade ago. The fifth edition includes the chapters 'Researching insights and solutions' and 'Google and search' by B. Moroz and the chapters 'Programmatic marketing and advertising' and 'Measuring advertising' by W. Lederer. It also covers cross-platform selling, Facebook and other social media, podcasting, etc. Overall, the book focuses on personal selling and the changes in approaches and skills it requires, while emphasising sales ethics. The book includes a glossary for digital advertising and links to materials available on the accompanying website; also, instead of future outlook, it provides links to the sources where readers can follow the news relevant to the topic.

Authors: Charles Warner, William A. Lederer, Brian Moroz

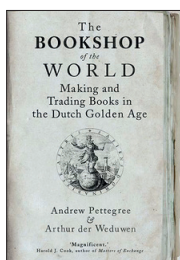
Publisher: Wiley-Blackwell  
5<sup>th</sup> ed., August 2020  
ISBN: 978-1-119-47739-6  
576 pages  
Softcover  
Available also as an eBook



## The Bookshop of the World Making and Trading Books in the Dutch Golden Age

The authors of this volume on Dutch book history provide rich information about the topic over the course of 150 years, building on comprehensive research and detailed analysis that allowed to show the interesting points and reveal new insights. The content documents the importance of print and the Dutch bookselling industry in early modern Europe. In the 17<sup>th</sup> century, the most books per capita were published in the Dutch Republic; the book industry products were bought by its citizens, contributing to a literate and well-informed population, and also constituted one of the major exports. It was possible thanks to the important innovations in print marketing and selling, which included newspaper advertising and book auctions, where millions of books were traded. Besides the books produced by the Dutch, their international book trade also involved large numbers of imported and re-exported books.

While many of the books published in this Dutch era belong to the masterpieces, the authors pay attention to all kinds of printed matter of that time to get a complete picture and better understand the evolution of the society. The survey includes the newspapers, different non-commercial prints, such as official ordinances or student dissertations, as well as the books intended for practical use, most of which had worn out and become forgotten. The text is complemented by carefully selected illustrations. The softcover edition of the book is available since September 2020.



*Authors: Andrew Pettegree, Arthur der Weduwen*

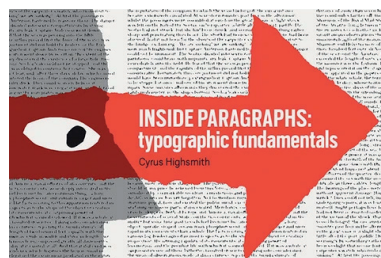
Publisher: Yale University Press  
1<sup>st</sup> ed., April 2019  
ISBN: 978-0-300-23007-9  
496 pages, 70 images  
Hardcover

## Inside Paragraphs Typographic Fundamentals

This book demonstrates the role of space within a letter, a word, a line and a paragraph through lucid descriptions and illustrated examples, generously presented on page spreads in a landscape format. The author explains the essential typographic concepts and terms in relation to readers' experience in an effective and engaging manner. After several translated editions issued since its first publication in 2012, the book is now available in the updated English edition and with a new preface.

*Author: Cyrus Highsmith*

Publisher: Princeton  
Architectural Press  
2<sup>nd</sup> ed., August 2020  
ISBN: 978-1-61689-941-7  
104 pages, 62 images  
Softcover



## Advances in Design and Digital Communication

*Editors: Nuno Martins, Daniel Brandão*



Publisher: Springer  
1<sup>st</sup> ed., November 2020  
ISBN: 978-3030616700  
617 pages, 276 images  
Hardcover  
Also as an eBook

The contributions in the Proceedings of Digicom 2020, the 4<sup>th</sup> International Conference on Design and Digital Communication held this November as an online event, are divided into four parts focused on digital and interaction design, design strategies and methodologies, pedagogy, society and communication in design practice, and graphic design and branding. The topics include, among others, the display issues with the Indian typefaces in digital platforms, a new tool for type design education, the future of film posters, the marketing and design perspectives on brands and rebranding, the soft skills developed in the transnational graphic design education in Sri Lanka, the benefits of visual representation of design process, and also the effect of visual communication in COVID-19 prevention and risk mitigation.

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

*Editors: Nuno Martins,  
Daniel Brandão, Daniel Raposo*



Publisher: Springer  
1<sup>st</sup> ed., July 2020  
ISBN: 978-3030496463  
238 pages, 87 images  
Hardcover  
Also as an eBook

This volume includes 15 chapters from the authors of the best papers presented at the 3<sup>rd</sup> edition of Digicom, the conference mentioned above, held in November 2019 in Barcelos, Portugal. They discuss, for example, the intersections between printed and digital media and the design of interactive narratives.

### Plastics Microstructure and Engineering Applications

*Authors: Nigel Mills,  
Mike Jenkins, Stephen Kukureka*

Publisher:  
Butterworth-Heinemann  
4<sup>th</sup> ed., February 2020  
ISBN: 978-0081024997  
336 pages, Softcover  
Also as an eBook

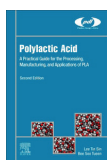


The current edition of this classic textbook on the properties and engineering of plastics, emphasising the specific aspects of mechanical design, has been substantially revised to reflect the progress in the fields relevant for plastic materials, including new insights into their microstructure and electrical properties, 3D printing, ageing, sustainability, life-cycle analysis and waste disposal considerations.

### Poly(lactic Acid) A Practical Guide for the Processing, Manufacturing, and Applications of PLA

*Authors: Lee Tin Sin, Bee Soo Tuen*

Publisher:  
William Andrew  
2<sup>nd</sup> ed., June 2019  
ISBN: 978-0128144725  
422 pages, Hardcover  
Also as an eBook



This guide begins with the overview of biodegradable polymers; then, it details the synthesis and production of poly(lactic acid), followed by its thermal, chemical, mechanical and rheological properties, as well as degradation and stability. The second edition also covers the use of additives and processing methods for poly(lactic acid), including their recycling requirements. One chapter is dedicated to injection moulding and 3D printing, which is further discussed among the applications of poly(lactic acid) in the next chapter. The last one then reviews the environmental assessment and international standards of polymer biodegradation.

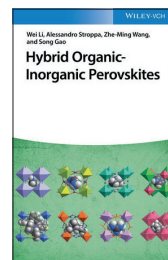
### Hybrid Organic-Inorganic Perovskites

The authors of this timely book review the recent developments of hybrid perovskites enabled by the homogeneous integration of organic and inorganic components at an atomic level. The opening chapter provides the background on perovskite oxides and the incorporation of organic components resulting in hybrid organic-inorganic perovskites, along with their classification and chemical variations. This chapter also outlines the structure, crystal symmetry, tolerance factor and physical properties of different hybrid perovskites, dependent on their composition, and explains the processes involved in their phase transitions.

The main content is clearly organised into eight chapters describing the individual types of hybrid perovskites – their synthesis, structures, phase transitions and specific physical properties. These include five chapters dedicated to hybrid halide, formate, azide, dicyanamide and cyanide perovskites, a joint chapter on hybrid dicyanometallate and borohydride perovskites, another one on hypophosphite perovskites, and the last one, which reviews other perovskite-like hybrid materials, namely the hybrid organic-inorganic perchlorates and tetrafluoroborates, and metal-free perovskites. Finally, the last chapter discusses the future research directions, challenges and opportunities in the field.

*Authors: Wei Li, Alessandro Stroppa,  
Zhe-Ming Wang, Song Gao*

Publisher: Wiley-VCH  
1<sup>st</sup> ed., October 2020  
ISBN: 978-3-527-34431-4  
292 pages  
Hardcover  
Available also as an eBook



### Flexible and Wearable Electronics for Smart Clothing

The first two parts of this book review the applications in sensing, presenting wearable organic nano-sensors, stimuli-responsive electronic skins and flexible thermoelectrics, and the applications for energy harvesting and storage, which include triboelectric nanogenerators, solar cells and supercapacitors, and lithium-ion batteries. The third part deals with the interaction of smart clothes with the human body, discussing thermal and humidity management, functionalisation of fibre materials, and flexible microfluidics for wearable electronics. The last part begins with a chapter on piezoelectric flexible bio-integrated electronics and then explores various processes and materials for fabrication of flexible and printed electronics for smart clothes, including the strategies of production upscaling.

*Editors: Gang Wang, Chengyi Hou, Hongzhi Wang*

Publisher: Wiley-VCH  
1<sup>st</sup> ed., June 2020  
ISBN: 978-3-527-34534-2  
360 pages  
Hardcover  
Available also as an eBook





# Bookshelf

## Academic dissertations

### Synthesis and Investigation of Functional Tröger's Base Molecules for Optoelectronic Applications

This thesis contributes to the research on organic compounds applicable in optoelectronic devices. Namely, it deals with tetracyclic Tröger's base molecules with two tertiary amine groups, exhibiting a specific rigid V-shaped chiral structure. The aim of the thesis was to synthesise and investigate novel functional Tröger's base compounds to be used as charge-generating double-acceptor dyes for dye-sensitised solar cells, solid-state light-emitting materials for organic light-emitting diodes, and well-performing amorphous hole-transporting materials for perovskite solar cells. The dissertation reviews the synthesis of Tröger's base, its reactions and analogues along with their use. The main part describes the series of experiments comprising the synthesis and characterisation of novel Tröger's base compounds. Four chapters explore their application as hole-transporting materials. Here, Tröger's base core was combined either with triphenylamine moieties that could be further extended by phenylethenyl moieties, or with TPD (N,N'-bis(3-methylphenyl)-N,N'-diphenylbenzidine) moieties, or with enamine-linked diphenyl branches. For all types, derivatives having methyl- or methoxy-substituents were prepared as well. The work presents thermal, optical and photoelectrical properties of all synthesised compounds. Except for the first type with the smallest molecules, their performance in perovskite solar cells was also successfully tested. Next, two chapters deal with metal-free sensitisers for dye-sensitised solar cells based on Tröger's base scaffold with triphenylamine and rhodanine-3-acetic acid moieties and their improvement by phenyl-branched hydrazone units. Then, the light-emitting materials containing tetraphenylethenyl moieties and Tröger's base core are presented. All measurements and materials are detailed before the conclusions.

#### Doctoral thesis – Summary

##### Author:

*Titas Braukyla*

##### Speciality field:

*Chemistry*

##### Supervisor:

*Vytautas Getautis*

##### Defended:

*20 September 2019,  
Kaunas University of Technology,  
Faculty of Chemical Technology,  
Department of Organic Chemistry  
Kaunas, Lithuania*

##### Contact:

*titas.braukyla@thermofisher.com*

### Image-Based Bidirectional Reflectance Measurement of Non-Diffuse and Gonio-Chromatic Materials

The general focus of this thesis was on a time- and cost-efficient way for optical characterisation of flexible packaging print materials that require bidirectional measurements. The aim was to investigate the possibility to use an image-based measurement setup to perform bidirectional reflectance measurements of flexible and homogeneous packaging print materials with complex optical properties. The thesis was also concerned with an analytical estimation of the bidirectional reflectance distribution function (BRDF) of materials using different reflectance models and a representation of material appearance from the data obtained using this measurement setup.

The dissertation provides the background on visual appearance and packaging print materials, bidirectional reflectance measurements and representation of BRDF, with an emphasis on the analytical BRDF models, and then presents the research work. The image-based measurement setup employed a halogen tungsten lamp of a film projector as a uniform point light source, illuminating the sample fixed on a cylinder of known radius, and a commercially available digital single-lens reflex camera as a detector. The positions of the light source, the detector and the sample were fixed, with

#### Doctoral thesis – Summary

##### Author:

*Aditya Suneel Sole*

##### Speciality field:

*Colour Imaging*

##### Supervisors:

*Peter Nussbaum  
Ivar Farup*

##### Defended:

*5 December 2019, Norwegian  
University of Science and Technology,  
Faculty of Information Technology and  
Electrical Engineering, Department of  
Computer Science  
Gjøvik, Norway*

##### Contact:

*aditya.sole@ntnu.no*

every point on the curved material surface making the corresponding incident and viewing directions with respect to the normal at that point. Each pixel in the image captured by the camera corresponds to a point on the curved sample surface. The BRDF of the measured sample was calculated from the captured image using the determined spectral sensitivity of the camera sensor. The measurement accuracy of this setup applied for flexible, homogeneous and isotropic packaging print materials was estimated by comparing it with two commercially available gonio-spectrophotometers. The uncertainty in estimating the incident and viewing directions, which was large due to the error in performing physical measurements, and the error in calculating the conversion matrix using the measured camera spectral sensitivities were identified as two main sources of error of the tested image-based measurement setup. Further studies investigated the applicability of the image-based measurement setup for packaging print materials with different reflectance properties ranging from diffuse to non-diffuse and gonio-chromatic. The highly non-diffuse materials required multiple-exposure captures to obtain an image with high dynamic range. The BRDF of the materials was estimated using different analytical reflectance models and parameters optimised using an appropriate cost function. The non-diffuse and gonio-chromatic reflectance properties were then visualised using BRDF estimated with optimal measurement dataset.

#### Doctoral thesis – Summary

Author:

*Jianfang Zheng*

Speciality field:

*Electrical Engineering*

Supervisors:

*Antti V. Räisänen*

*Zachary D. Taylor*

Defended:

*10 February 2020, Aalto University,*

*School of Electrical Engineering,*

*Department of Electronics and*

*Nanoengineering*

*Espoo, Finland*

Contact:

*jianfang.zheng@hotmail.com*

#### **Millimeter-Wave Antennas on Flexible Substrates: Roll-to-Roll Reverse-Offset Printing and Probe Station-Based Characterization**

The research within this thesis dealing with the next-generation communication systems operating at millimetre-wave frequencies addressed the challenges related to the requirements on manufacturing and characterisation of the antenna. The chosen approach to low-cost and high-resolution fabrication of millimetre-wave antennas on flexible substrates employs roll-to-roll reverse-offset printing. The thesis also systematically studies the methods to quantify radiation performance in terms of gain and radiation pattern for the on-wafer antennas in a probe station environment. The dissertation introduces the topic and the roll-to-roll reverse-offset printing technique capable of producing micron-sized features, discussing the suitable printing substrates and conductive inks as well as the need for supporting pillars when printing large conductive areas in order to avoid pattern distortion caused by the elasticity of the polydimethylsiloxane blanket. The design simulations accounted for the holes resulting from the use of tiny supporting pillar structures. The results for W band (75–110 GHz) indicated a strong positive correlation between the loss and the number of holes. The design comprised microstrip patch antenna structures fed with coplanar waveguide transmission lines. The samples were produced by roll-to-roll reverse-offset printing of silver nanoparticle ink dispersed in ethanol on polyethylene naphthalate substrate, with the ground on the backside evaporated separately. The measurements in an on-wafer probe station confirmed sufficient conductivity of the printed ink layers for millimetre-wave antennas. The measured magnitude of broadside realised gain reached 4.5 dBi. The second part of the work presents the method of antenna gain measurement using a specular conductor plate as a reflector instead of the second antenna to reduce the complexity of the measurement system. The considerations included the influence of reflector size on measurement accuracy estimated using physical optics and simulations of both ideally and imperfectly aligned reflector. By adding a rotator in the setup, the one-antenna method also allows the measurement of antenna radiation patterns. The proposed method was applied to antennas with different beam directions.

# Events

## EI 2021 – IS&T International Symposium on Electronic Imaging

electronic  
IMAGING2021 <https://www.imaging.org>  
18–21 & 25–28 January 2021

The schedule of the 2021 online edition combines the sessions of 18 technical conferences, featuring about 30 keynotes and four plenary speakers. In the first week, participants can hear from Michal Irani, presenting deep internal learning without any prior examples or training data, and Kenneth A. Parulski, reviewing the development of integral colour image sensors from the early beginning to opportunities for the future. The second week opens the plenary by Ramesh Raskar sharing highlights of femto-photography, which enables unique imaging and computer vision applications. The last plenary speaker is Luca Verre presenting the principle of event-based vision and its application in new bio-inspired machine vision systems.

The conference is preceded by a five-day short-course programme in the week of 11 January, which this year offers 23 short courses. These include two new courses, one presenting hardware of 3D imaging systems and its calibration and the other introducing the event detection camera, and several updated courses, dealing with the resolution in mobile imaging devices, compact camera modules for augmented and virtual reality, automotive and machine vision applications with a focus on colour, optics and calibration, and sources of camera noise and its characterisation. All recordings of short courses and technical sessions can be then accessed until 30 April 2021.

## FLEX 2021



<https://flex.semi.org/>  
22–26 February 2021

The agenda of the 20<sup>th</sup> anniversary of the FLEX conference and exhibition includes four session days dedicated to flexible hybrid electronics systems, materials processing, sensors and micro-electro-mechanical systems, and sustainability and power, which are followed by a day with virtual tours and demonstrations. Participants can preview the presentations during the preceding week (15–21 February) and prepare their questions for the live event that each day combines keynotes, panel discussions, short talks from expert speakers, student posters, and more. The approved content then remains available for on-demand access until 26 March 2021.

The keynote topics announced so far include the approaches to safe and responsible development and deployment of advanced nanomaterials needed to identify and mitigate potential health and environmental hazards presented by Charles Geraci, Jr., recent advances in the interfacing of electronics with the human brain reviewed by George Malliaras, the progress in safe and high-performance power sources with respect to their chemistry, device architecture, manufacturing and integration explored by Christine Ho, as well as additive manufacturing of flexible printed circuit boards by Masaaki Sugimoto and the MicroLED display technology by Falcon Liu.

## Changes in the calendar of events continue in 2021

The Color 2021 conference hosted by the PRINTING United Alliance was at first postponed to June and then fully cancelled. The next edition is scheduled for January 2022. The sessions of the PRINTING United Digital Experience successful autumn event are freely available on-demand through the end of January 2021.

Similarly, the TAGA Annual Technical Conference has been rescheduled to March 2022. However, the Technical Association of the Graphic Arts will publish the 2021 Proceedings and the call for papers is still open, so as for the 2021 TAGA Student Competitions. This time, groups compete with the electronic journals of student research instead of the traditional printed ones, which is an opportunity to engage more institutions worldwide. The Levenson Undergraduate Student Paper and Rhodes Graduate Student Paper competitions for individuals are open to all students in higher education, regardless of TAGA chapter membership.

The PrintPack India 2021 Exhibition has been postponed from February, with new dates yet to be announced. The next edition of Graphispag in Barcelona, Spain is moved from 2021 to May 2022. The FESPA Brasil show in São Paulo is still announced for 24–27 March 2021. The Labelexpo Americas 2021 show to be held in Rosemont, Illinois, USA, and previously planned for March, is now scheduled for 8–10 June 2021. The other events moved from March to June 2021 include Packaging Innovations and Empack Birmingham (announced for 17–18 June) and the 5<sup>th</sup> International Exhibition of Print Technology for Industrial Manufacturing held in Germany, InPrint Munich (22–24 June). The latter one is co-located with the 12<sup>th</sup> International Converting Exhibition and the 5<sup>th</sup> International

Exhibition for the Corrugated and Folding Carton Industry. Similarly, the London Book Fair is currently rescheduled from March to summer (29 June to 1 July 2021). Considering the ongoing pandemic situation, all dates listed above are tentative.

Last but not least, the drupa trade fair has been cancelled also for 2021, with a four-day digital event, virtual.drupa, announced within the period originally planned for drupa 2021, from 20 to 23 April.

### Other online events held in the first months of 2021

The 24<sup>th</sup> edition of SGI Dubai 2021, the Sign & Graphic Imaging show, takes place online on 18–20 January (<https://www.signmiddleeast.com>).

Among the Jakajima events, the 8<sup>th</sup> 3D Printing Electronics Conference is held on 21 January (<https://www.3dprintingelectronicsconference.com>); later, on 9 March, the 6<sup>th</sup> edition of the 4D Printing & Meta Materials Conference can be joined (<https://www.4dpmmconference.com>). The courses of the IMI Europe Inkjet Winter Workshop 2021 (<https://imieurope.com>), as well as the EFI Engage Virtual Conference sessions (<https://www.efi.com>), are offered between 25 January and 5 February.

The Digital Document Security conference is held on 3–4 February (<https://digitaldocumentsecurity.com>), followed by the 15<sup>th</sup> International

Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, VISIGRAPP 2021 on 8–10 February (<http://www.visigrapp.org>), the World Congress on Textile Coating on 11–12 and 18–19 February (<https://www.technical-textiles.net>), and the Digiday Publishing Summit Worldwide LIVE on 24–26 February (<https://digiday.com>). Next month, the Digital Media India 2021 takes place on 2–4 March (<https://events.wanifra.org>), the trade fair and conference LOPEC 2021 on 23–25 March (<https://www.lopec.com>), and the Intergraf Currency+Identity Conference and Exhibition on 24–26 March (<https://intergrafconference.com>).

### innoLAE 2021 Innovations in Large-Area Electronics

<http://innolae.org>  
22–25 February 2021



The 7<sup>th</sup> annual innoLAE event is organised by IMI Europe and held online. Its programme begins with two half-day courses covering the wet and dry processing technologies for large-area electronics and the industry networking day. The conference on the next two days offers both oral and poster presentations, with a dozen invited talks confirmed up to now. The schedule features the keynotes on 'Skin-inspired electronics and sensors' by Zhenan Bao, 'Novel bio-electronics for ICU-grade monitoring in premature neonates' by Steve Xu, and 'Enabled textiles that transform human connectedness in a socially distant world' by Tony Chahine.

### SPIE Events

#### Photonics West 2021

**SPIE. PHOTONICS WEST** <https://spie.org>  
6–11 March 2021

The 2021 edition of this event that belongs to the main ones organised by SPIE is also transformed into the Digital Forum. A free online series of photonics webinars, Photonics West Preview, can be joined on 25–28 January. During the Photonics West in March, only Digital Marketplace and industry sessions can be attended for free.

Across individual conferences of the Photonics West Digital Forum, numerous contributions present the research involving printing. These include the keynote presentation on high-speed polymer 3D printing and several other papers within the 8<sup>th</sup> Laser 3D Manufacturing conference, invited talks on 3D micro-printing, micro-transfer printing and micro-solid printing processes and their applications, presentations dealing with printed polymer optical waveguides, polarising beam-splitter, resonant nanocones for THz field-driven photoemission, and more.

#### Smart Structures / Nondestructive Evaluation 2021

**SPIE. SMART STRUCTURES+ NONDESTRUCTIVE EVALUATION** <https://spie.org>  
7–10 March 2021

This SPIE Digital Forum organised in the same period also features many applications of printing technology. The topics cover the inkjet printing of mm-scale electrostatic actuators, electrical and mechanical characterisation of medical-grade silicones in dielectric elastomers produced by aerosol-jet printing, performance evaluation of 3D-printed magnetorheological elastomers, 3D-printed polypyrrole biosensors with integrated pH-activated drug delivery, and the non-contact health monitoring system for gears manufactured by printing conductive ink, for example. The programme also includes the invited talk discussing printed skin-conformal bioelectronics for wireless continuous stress monitoring and management, and the session on 3D Printing and Novel Materials presenting, among others, the method that enables 3D printing with the high-concentration nanocellulose ink.