Printing for Fabrication 2021

Online
11 - 12 October 2021

ISBN: 978-1-7138-4138-8

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PRINTING FOR FABRICATION 2021: SCHEDULE AND TECHNICAL PAPERS

DAY 1
MONDAY 11 OCTOBER / TUESDAY 12 OCTOBER

WELCOME AND OPENING KEYNOTE

Session Chair: Ron Askeland, HP Emeritus Engineer with MBO Partners (US)
11 OCTOBER:
10:00 – 11:05 NEW YORK / 15:00 – 16:05 LONDON / 23:00 – 00:05 TOKYO

Welcome Remarks, *Teruaki Mitsuya, Ricoh Company, Ltd. (Japan)*

MXene Inks Replace Metals and Carbon in Printed Electronics?,
Yury Gogotsi, Drexel University (US) . . . . . *

Two-dimensional transition metal carbides and nitrides known as MXenes (more than 50 compositions are currently available) exhibit high metallic conductivity (up to 20,000 S/cm), catalytic, plasmonic, reversible redox, and other useful properties. This presentation provides an overview of MXene synthesis and properties, as well as aqueous and organic MXene ink formulations. Examples of extrusion printing, inkjet printing, and screen printing on various substrates, including paper, textiles, and polymers, is provided. Due to their versatile chemistry and facile processability, MXenes are promising candidates for the next generation of printed devices such as interconnects, electrodes for batteries and supercapacitors, antennas, and sensors.

IS&T Award Presentations
Frits Dijksman, *Joahnn Gutenberg Prize for great achievements to process physics and applications of ink jet technologies*
Mack Sowers, *Raymond Davis Scholarship*

11 Oct: 11:05 – 11:30 (New York) / 16:05 – 16:30 (London)
12 Oct: 00:05 – 00:30 (Tokyo)
SESSION BREAK
Join the keynote speaker and other attendees for informal discussions and networking.

DEPOSITION TECHNOLOGY I

Session Chair: Alvaro J. Rojas, Universidad Autonoma de Occidente (Colombia)
11 OCTOBER: 11:30 – 12:25 NEW YORK / 16:30 – 17:25 LONDON
12 OCTOBER: 00:30 – 01:25 TOKYO

11:30 (New York) / 16:30 (London)
00:30 (Tokyo)
FOCAL TALK Novel Piezo Inkjet Technology and Printhead Capable of Jetting Extreme Viscosity Fluids for Additive Manufacturing,
Ben Hartkopp and Marcel Strobel, Quantica GmbH (Germany), and Ramon Borrell, borrell.uk Technology Management (UK) **1**

This paper unveils for the first time a new technology using a novel operation mode for piezo inkjet printheads invented to close the limitations of current commercial printheads in meeting the requirements for advanced additive manufacturing. Subsequently, a printhead using the new technology has been developed along with the necessary sub-systems for integration in a printer. The new inkjet technology brings a combination of advantages, the most relevant being the capability to jet extremely high viscosity fluids, combined with very high productivity per nozzle, very wide drop size control, and the capability to jet fluids with high particle load and large particle sizes. A family of 3D printers for different applications such as realistic permanent dental fixtures is being developed using the new printhead. Multiple applications in additive manufacturing and microfluidics will benefit from the unique qualities of the new technology.

11:55 (New York) / 16:55 (London)
00:55 (Tokyo)
JIST-FIRST On-demand Electrohydrodynamic Jetting of an Ethylene Glycol and Water Mixture—System of Controlled Picoliter Fluid Deposition, *J. Frits Dijksman, University of Twente (the Netherlands), and Urzsula Stachewicz, AGH University of Science and Technology (Poland)* **5**

On-demand electrohydrodynamic jetting also called electrohydrodynamic atomization (EHDA) is a method to jet small amounts of fluid out of a nozzle with a relatively large diameter by switching on and off an electrical field between the nozzle and the substrate. The total amount of volume deposited is up to 5 pL. The set-up consists of a vertically placed glass pipette with a small nozzle directed downward and a flat substrate placed close to the end of the nozzle. Inside the pipette, an electrode is mounted close to the entrance of the nozzle. The electrode is connected to a high voltage power amplifier. Upon switching on the electrical field, the apparent surface tension drops, the meniscus deforms into a cone and fluid starts to flow toward the nozzle deforming the meniscus. At a certain moment the cone reaches the Taylor cone dimensions and from its tip a jet emerges that decomposes into a stream of charged fL droplets that fly toward the substrate. This process stops when the pulse is switched off. After switching off, the meniscus returns slowly to its equilibrium position. The process is controlled by different time constants, such as the slew rate of the power amplifier and the RC time of the electrical circuit composed of the electrical resistance in the fluid contained in the nozzle between the electrode and the meniscus, and the capacitance of the gap between the meniscus and the flat substrate. Another time constant deals with the fluid flow during the growth of the meniscus, directly after switching on the pulse. This fluid flow is driven by hydrostatic pressure and opposed by a viscous drag in the nozzle. The final fluid flow during droplet formation is governed by the balance between the drag of the charge carriers inside the fluid, caused by the current associated with the charged droplets leaving the meniscus and the viscous drag. These different phenomena will be discussed theoretically and compared to experimental results.

12:10 (New York) / 17:10 (London)
01:10 (Tokyo)
The Use of 3D Printed Foundry Patterns for Aluminum Casting with Oil Bonded Sand Molds, *Tavs Jorgensen and Sonny Lee Lightfoot, University of the West of England (UK)* **A-1**

This paper presentation outlines early-stage results from research into the use of low-cost 3D printing to create foundry patterns for Aluminum metal casting with oil bonded sand molds. The paper outlines findings and observations in relation to the practical challenges in using Fused

**Abstract only; no proceedings paper.*

Deposition Modeling (FDM) 3D printing for this application. The paper provides observations from first-hand practical investigations of the complete workflow including pattern design, fabrication via 3D printing, mold making, casting, and fettling/finishing of the parts. Observations will be delivered as researcher reflections of the process and include details for strategies and approaches in relation to the use of patterns with the particular surface texture that is characteristic of FDM produced parts. Numerical data will be provided to assess final aluminum part accuracy in relation to the printed pattern.

DEPOSITION TECHNOLOGY GROUP DISCUSSION I

Discussion Moderator: Ingo Reinhold, HTWK - Leipzig University of Applied Sciences (Germany)

11 OCTOBER: 12:25 – 12:55 NEW YORK / 17:25 – 17:55 LONDON
12 OCTOBER: 01:25 – 01:55 TOKYO

Group discussion on deposition technology featuring the following Short Course Instructors
—Mark Bale, DoDxAct Ltd.: *Practical Inkjet Ink Characterization*
—Neil Chilton, PEL: *Printed Electronics*
—J. Frits Dijksman, University of Twente: *Inkjet Fluid Dynamics and Fundamentals*
—Tim Phillips, Catenary Solutions/IMI Europe: *Inkjet Ink Manufacturing*

11 Oct: 12:55 – 13:20 (New York) / 17:55 – 18:20 (London)
12 Oct: 01:55 – 02:20 (Tokyo)
SESSION BREAK

Join the speakers and other attendees for informal discussions and networking.

SUSTAINABILITY: CIRCULAR ECONOMY OF PAPER

Session Chair/Discussion Moderator: Ron Askeland, HP emeritus engineer with MBO Partners (US)

11 OCTOBER: 13:20 – 14:30 NEW YORK / 18:20 – 19:30 LONDON
12 OCTOBER: 02:20 – 03:30 TOKYO

Fifteen minute presentations followed by a moderated discussion.

Introduction to the Problem and Zero Waste Principles, *Rick Anthony, Rick Anthony Associates (US)*

Importance of Seeing the Printing Business as Part of an Interconnected Circularity, *Susan Kinsella, Recycling Archives and Conservatree (US)*

General State of Recyclability and Paper Recycling, *Axel Fischer, INDEGE e.V. (Germany)*

Global Paper Recycling Issues and Impact on Inks, *William Moore, Moore & Associates (US)*

Break in program to accommodate time zones

PRINT4FAB KEYNOTE II

Session Chairs: Teruaki Mitsuya, Ricoh Company, Ltd. (Japan), and Dong-Youn Shin, Pukyoung National University (Republic of Korea)

11 OCTOBER: 19:00 – 20:05 NEW YORK
12 OCTOBER: 00:00 – 01:05 LONDON / 08:00 – 09:05 TOKYO

Welcome Remarks, *Teruaki Mitsuya, Ricoh Company, Ltd. (Japan)*

Inkjet based Direct Printing Methods for Non-flat Surfaces,
Kye-Si Kwon, Soonchunhyang University (Republic of Korea). **A-3**
Direct to shape printing on non-flat surfaces is the preferred method for packaging industries, such as bottle and can printing. Such direct printing methods are more efficient than indirect printing methods, and thus are extending their use to non-graphic applications. This presentation discusses direct printing methods for various applications of non-flat surface printing, such as beauty lenses and printed electronics applications. In particular, this talk covers how to apply high-viscosity inks to various geometries using numerous printing methods, such as near-field electrospinning, continuous inkjet, and needle-type dispensers, to meet a variety of industrial requirements.

IS&T Award Presentation
Teruaki Mitsuya, *Chester F. Carlson Award for significant contributions in the field of electrophotographic process technologies*

11 Oct: 20:05 – 20:30 (New York)
12 Oct: 01:05 – 02:20 (London) / 09:05 – 09:30 (Tokyo)
SESSION BREAK

Join the keynote speaker and other attendees for informal discussions and networking.

DEPOSITION TECHNOLOGY II

Session Chair: Makoto Omodani, Tokai University (Japan)

11 OCTOBER: 20:30 – 21:40 NEW YORK
12 OCTOBER: 01:30 – 02:40 LONDON / 09:30 – 10:40 TOKYO

20:30 (New York)
01:30 (London) / 09:30 (Tokyo)
FOCAL TALK **Meniscus Inversion Mechanism and its Impact on the Droplet Formation of an Inkjet Printhead,** *Dong-Youn Shin, Pukyong National University (Republic of Korea)* **A-6**
The liquid-air interface, i.e., meniscus, is formed at the nozzle of an inkjet printhead and it shows a back and forward reciprocating motion as negative and positive pressure waves alternatingly reach the nozzle. However, it does not show a simple reciprocating motion like an elastic membrane. Instead, it first forms a concave surface while it retreats toward the inside of an inkjet print head with the arrival of a negative pressure wave. Then, it starts forming a protruded region around its center on a convex surface while the meniscus moves forward as a positive pressure wave reaches the nozzle, as shown in Fig. 1. The protruded region become larger until its radius becomes equal to the nozzle radius of an inkjet printhead. The underlying question lies in what leads to this meniscus inversion, resulting in an asymmetric reciprocating motion. Herein, a mathematical model, entitled 'window model,' is proposed to explain the meniscus inversion using the ratio of kinetic and surface energy change rates. Using the developed window model, the impact of the meniscus inversion on the droplet formation is discussed in the end.

20:55 (New York)
01:55 (London) / 09:55 (Tokyo)

An Electrospray Coating Method using Multi-nozzle Head, *Mosa Md Abu, Se Hyun Kim, and Kye-Si Kwon, Soonchunhyang University (Republic of Korea)* **A-7**

Electrospray is an effective method for coating on a substrate due to homogenous and relatively finer size of the droplets. Most of the research work on electrospray are based on single nozzle configuration. A multi-nozzle spray system is required for high throughput production of large area coating for commercial use. However, the cross-talk and deposition uniformity from each nozzle has been critical issues to be solved. In this study, the process for the uniform coating will be discussed. To achieve the uniformity, we propose zig-zag motion for deposition and fast evaporation using hot-blow right after the deposition. As demonstration of our proposed method, we will show that superhydrophobic layer can be uniformly deposited on highly insulating substrate.

21:10 (New York)
02:10 (London) / 10:10 (Tokyo)

Effects of Embedded Depth of Internal Printed Ferromagnetic Cell on Data Clarity of Rewritable 3D Objects, *Piyarat Silapasuphakornwong[1], Hideyuki Torii[1], Masahiro Suzuki[2], and Kazutake Uehira[1]; [1]Kanagawa Institute of Technology and [2]Seisen University (Japan)* **28**

We proposed the method for non-destructively embedding information inside a 3D fabricated object very clearly by the process of re-magnetization. Our strong points are that the 3D object is finished (ready to use) after only a printing process, and is able to be reused by re-writing information many times. In this paper, we investigated the effects of the depth (positions inside the object) of the storage cell, which is printed as a ferromagnetic filament, on the clarity of the embedded information. Our purpose: we need to find the conditions that gave the most benefit in both obtaining high magnetic strength and protecting the embedded information. With this advantage, the method leads to the production of creating the high-quality household 4D object, the personal interactive 3D object, in the near future.

21:25 (New York)
02:25 (London) / 10:25 (Tokyo)

Versatility of Laser Enhanced Direct Print Additive Manufacturing, *Omer F. Firat[1], Roger Tipton[2], Venkat Bhethanabotla[2], Jing Wang[2], and Thomas Weller[1]; [1]Oregon State University and [2]University of South Florida (US)* **32**

This paper provides examples of the use of direct print additive manufacturing to fabricate RF/microwave and optical components. Direct print additive manufacturing is the combination of extrusion and micro-dispensing on a single tool. The design, 3D printing process and material selections for finite ground coplanar waveguide (FG-CPW) planar transmission lines, the integration of DC contact RF MEMS switches within the FG-CPWs, and optical interconnects are detailed. Picosecondpulsed laser machining is performed to enhance the finish quality of the devices and achieve minimum feature size down to 6 µm specifically for the RF switch.

11 Oct: 21:40 – 22:05 (New York)
12 Oct: 02:40 – 03:05 (London) / 10:40 – 11:05 (Tokyo)

SESSION BREAK

Join the speakers and other attendees for informal discussions and networking.

DEPOSITION TECHNOLOGY III

Session Chair: Atsushi Tomotake, Konica Minolta, Inc. (Japan)

11 OCTOBER: 22:05 – 22:50 NEW YORK
12 OCTOBER: 03:05 – 03:50 LONDON / 11:05 – 11:50 TOKYO

22:05 (New York)
03:05 (London) / 11:05 (Tokyo)

Stealth Illuminated Printing with On-demand Melt Thermal Transfer Printer, *Kenta Suzuki, Emi Miyashita, Hiroshi Kobayashi, Masahito Watanabe, and Hirotoshi Terao, Alps Alpine Co., Ltd. (Japan)* **A-9**

Combining on-demand thermal transfer technology with the capacitive sensor, we are developing a touch device capable of stealth illuminating in addition to reproducing the tactile sensation of wood grain. On the other hand, there is a problem that the brightness is low when the stealth illumination is applied. In addition to symbol display, there is also a demand for graphic display on a liquid crystal display. In this paper, we report how to improve stealth illumination and support liquid crystal display.

22:20 (New York)
03:20 (London) / 11:20 (Tokyo)

Fabrication and Characterization of 3D Printed Magnetic Polymer Nanocomposites, *Madeleine Cannamela[1,2], Jim Stasiak[2], and Pallavi Dhagat[1]; [1]Oregon State University and [2]HP Labs (US)* **A-11**

This presentation will detail an inkjet additive manufacturing process and characterization techniques for fabrication of magnetic polymer nanocomposites with systematically controlled magnetic properties. Magnetic nanocomposites were 3D printed by lab-scale and manufacturing-scalable printers. Nanocomposites were characterized for saturation magnetization and magnetic permeability. Effective medium theory allowed modeling of composite magnetic permeability as a function of the concentration of magnetic nanoparticles. This research expands on work presented at Printing for Fabrication 2020.

22:35 (New York)
03:35 (London) / 11:35 (Tokyo)

Aesthetic Photovoltaic System with Printed Quantum-Dot Layer, *Hyung-Jun Song, Seoul National University of Science and Technology (Republic of Korea)* **A-13**

Graphical and aesthetic PVs have drawn much attention, as the installation of building integrated photovoltaic (PV) increases. In this work, we developed aesthetic and graphical c-Si PV panels by incorporating soluble core/shell type quantum dots (QDs) through inkjet printing. Core/shell QDs generate visible color using UV and deep blue light through down-converting process, which enables us to minimize photon loss for color appealing of PVs. Moreover, down converting QDs can be located on a desirable position via an inkjet printing method. Especially, modifying its solvent and printing speed, high resolution graphical image can be achieved in the front glass of PV panels. Furthermore, controlling concentration of QDs for printing provides to present vivid color image and graphic by deepening the color depth. Therefore, the proposed color generation method for opaque PVs, based on core/shell QDs and inkjet printing technology, will allows us to replace monotonous black PV panels into aesthetically pleasing energy generation sources with small losses.

DEPOSITION TECHNOLOGY GROUP DISCUSSION II

Discussion Moderator: Garrett E. Clark, HP Inc. (US)

11 OCTOBER: 22:50 – 23:20 NEW YORK
12 OCTOBER: 03:50 – 04:20 LONDON / 11:50 – 12:20 TOKYO

Group discussion on deposition technology featuring the following Short Course Instructors

—Rich Baker, Integrity Industrial Ink Jet Integration LLC: *Industrial Inkjet*
—Chunghui Kuo, Eastman Kodak Co.: *Electrophotography and Machine learning (2019)*
—Paul McConville, Xerox Corp.: *Direct-to-Object Printing*
—James W. Stasiak, HP Labs: *Intro to Digital Fabrication and Additive Manufacturing*

DAY 2
TUESDAY 12 OCTOBER / WEDNESDAY 13 OCTOBER

EXPERIMENTAL PRINTING

Session Chair: M. Cristina Rodriguez-Rivero, University of Cambridge (UK)

12 OCTOBER:
10:00 – 11:05 NEW YORK / 15:00 – 16:05 LONDON / 23:00 – 00:05 TOKYO

Welcome Remarks,
Ron Askeland, HP Emeritus Engineer with MBO Partners (US)

10:10 (New York) / 15:10 (London) / 23:10 (Tokyo)
FOCAL TALK One and Many: Wet-Collodion and Woodburytype,
Susanne Klein, University of the West of England (UK), and Paul Elter, Elter Studios (Canada) **37**
The invention of photography in the 19th century changed our perception of reality forever. Without the interpretation of an artist, an image could be recorded within minutes representing 'unfiltered' reality. Besides the scientific challenge how to capture the light and make the image permanent, the distribution of the image material became a scientific and commercial endeavor at the same time. We will present modern reincarnations of two technologies practiced by Walter Woodbury, the inventor of the first commercially successful photomechanical reproduction method: Merging Wet-Collodion Photography and Woodburytype.

10:35 (New York) / 15:35 (London) / 23:35 (Tokyo)
An Intuitive, Imaginative, & Interactive Art Experience, *Anu Nadimpalli, 3am inspirations (Spain)* **A-14**
An Intuitive, Imaginative, & Interactive Art Experience uses unconventional media, techniques, and style to create an instrument of healing for healers/designers/general public.

The purpose of the author is to create art that becomes an expression of healing one´s sensory perceptions, to the fullest extent. This technique adds an extra ´dimension´ and experience to conventional techniques and methods. It becomes a vital tool for professionals in the healing and design industry, as they constantly seek to provide that extra value to their ever changing and sophisticated clientele.

10:50 (New York) / 15:50 (London) / 23:50 (Tokyo)
Recreating the Relief of the Temple of the Jaguars: Exploring Digital and Analogue 2.5D Printing of Mesoamerican Imagery, *Abigail Trujillo Vazquez, Xavier Aure, Susanne Klein, and Carinna Parraman, University of the West of England (UK)* **41**
Digital and analogue printing methods are studied for reconstructing a Mayan decorative relief from the ancient temple of the Jaguars. Height maps, image files encoding height information as intensity values, were produced in commercial image editing software from early 20th century photographic records. Physical height was generated in different materials through analogue printing processes including casting and embossing from photo exposed polymer plates, and digital processes including 2.5D elevated printing and stereolithography. The surface geometry of the outcomes from the analogue processes was recorded using photometric stereo to obtain feedback on the translation of the grayscale range onto relief. 2.5D prints produced with Canon Elevated Printing and stereolithography were used for comparison and qualitive assessment. Differences, parallels, and sustainability of the processes are discussed.

12 Oct: 11:05 – 11:30 (New York) / 16:05 – 16:30 (London)
13 Oct: 00:05 – 00:30 (Tokyo)
SESSION BREAK

Join the speakers and other attendees for informal discussions and networking.

SYSTEM INTEGRATION I

Session Chair: Neil Chilton, Printed Electronics Ltd. (UK)
12 OCTOBER: 11:30 – 12:55 NEW YORK / 16:30 – 17:55 LONDON
13 OCTOBER: 00:30 – 01:55 TOKYO

11:30 (New York) / 16:30 (London)
00:30 (Tokyo)
FOCAL TALK Digital Textile Printing: Status Report 2021, *Hitoshi Ujiie, Thomas Jefferson University (US)* **47**
Digital textile printing technology has been considered the preferred textile printing technology since 2003, when production digital textile printers were first introduced at ITMA (International Exhibition of Textile Machinery) in Birmingham, UK. However, in 2021, 18 years later, this technology is utilized in fewer than 10% of the entire textile printing industry. In this document, we aim to summarize the state-of-the-art of the digital textile printing industry and to predict its future trajectory.

11:55 (New York) / 16:55 (London)
00:55 (Tokyo)
Inkjet Printing for Bio-functionalization of Paper-based Biosensing Cards in a Roll-to-Roll Fabrication Pilot Line, *Tim Kothe, Giorgio C. Mutinati, Thomas Maier, and Rainer Hainberger, AIT Austrian Institute of Technology GmbH (Austria); Mike Pickrell, Sun Chemical (UK); and Oliver Broom and Yuanyuan Zhou, Ricoh UK Products Ltd. (UK).* **A-16**
Up to date, fabrication lines for mass production mostly focus on individual fabrication processes and device concepts. In this manner, conventional mass printing technologies, e.g. flexo- and screen-printing, have been combined, but the integration of inkjet-printing has not been shown on that technology level. Here, we propose a printing pilot line that clearly advances the current state-of-the-art and paves the way towards the real-world application of paper-based quantitative electrochemical diagnostic test cards. In particular, we present the aspects of inkjet-printing related to the development of ink-vehicles for biofunctionalization, their printability in lab-scale and the process transfer to industrial printheads by guaranteeing the functionality of the biochemical assay.

12:10 (New York) / 17:10 (London)
01:10 (Tokyo)
Investigation of Model-based Design Process of Temperature Control in Direct Thermal Printing, *Takashi Fukue, Kanazawa Institute of Technology, and Hirotoshi Terao, ALPS ALPINE Co., Ltd. (Japan)* . . **A-18**
This paper describes the development of the temperature prediction method of direct thermal printing (DTP) processes from the viewpoint of model-based design. A temperature prediction model of a direct thermal printer was developed by using OpenModelica. Primarily, we developed a functional model of natural convection and radiation heat transfer between the printer and the atmosphere that thermal resistance is affected by their temperature difference. In this paper, the present situation about the development of the analytical model is reported.

12:25 (New York) / 17:25 (London)
01:25 (Tokyo)
Kissel+Wolf - Screen Printing Application, *Andreas Künkele, Kissel+Wolf GmbH (Germany)* **A-19**
Set Up Screen Printing Technology is an analog printing process in an increasingly digital world. This process is established through automation and standardization. There are numerous application examples of screen printing for printed electronics. These examples, which include textiles, automotive, and ceramics, show that the screen printing process is competitive thanks to automated processes and its strengths. In addition to the examples of screen printing, this talk presents an excerpt from a project working on printed electronics: Latest Finline Testing.

12:40 (New York) / 17:40 (London)
01:40 (Tokyo)
JIST-FIRST Digital Textile Ink-jet Printing Innovation: Development and Evaluation of Digital Denim Technology, *Ming Wang, Lisa Parrillo-Chapman, Lori Rothenberg, Yixin Liu, and Jiajun Liu, North Carolina State University (US)* **53**
This research explored the potential for ink-jet printing to replicate the coloration and finishing techniques of traditional denim fabric and standardized the reproduction and evaluation procedure. Although denim fabric is widely consumed and very popular, one drawback to denim is that the finishing and manufacturing processes are energy and water intensive and can cause environmental hazards as well as generation of pollution through water waste, particularly at the finishing stage. Textile ink-jet printing has the potential to replicate some of the coloration and finishing techniques of traditional denim fabric without negative environmental impacts. A two-phase research project was conducted. In Phase I (P1), an optimal standard production workflow for digital denim reproduction (including color and finishing effects) was established, and six different denim samples were reproduced based on the workflow. In Phase II, an expert visual assessment protocol was developed to evaluate the acceptance of the replicated digital denim. Twelve ink-jet printing, color science, and denim industry experts finished the assessment.

12 Oct: 12:55 – 13:20 (New York) / 17:55 – 18:20 (London)
13 Oct: 01:55 – 02:20 (Tokyo)
SESSION BREAK

Join the speakers and other attendees for informal discussions and networking.

GROUP DISCUSSION ON SYSTEM INTEGRATION

Discussion Moderator: Susanne Klein, University of the West of England (UK)
12 OCTOBER: 13:20 – 13:50 NEW YORK / 18:20 – 18:50 LONDON
13 OCTOBER: 02:20 – 02:50 TOKYO

Group discussion on deposition technology featuring the following Short Course instructors/speakers

—Steven Abbott, Steven Abbott TCNF Ltd.: *Optimizing Printed Adhesion: Surfaces; Formulations, Processes*
—Ron Askeland, HP Emeritus Engineer with MBO Partners: *Digital Textile Printing*
—Matti Mantysalo, Tampere University: *On-skin Electronics by Printing*
—Hitoshi Ujiie, Thomas Jefferson University: *Digital Textile Printing*

LATE BREAKING NEWS – DIRECT-TO-SHAPE PRINTING

Session Chair/Discussion Moderator: Werner Zapka, WZA-Consulting (Sweden)
12 OCTOBER: 13:50 – 14:20 NEW YORK / 18:50 – 19:20 LONDON
13 OCTOBER: 02:50 – 03:20 TOKYO

5-minute presentations followed by a moderated discussion.

Polytype (Switzerland) *discusses machines and applications;* **KRONES (Germany)** *discusses printing onto containers, bottles, etc.. Both discuss what they could do with improved printheads (i.e., jetting at high distance and related issues).*

MEMJET (US) and Konica Minolta (Japan) *discuss printing at high distance, with high resolution and high speed, and how they could improve the printheads further to address the questions from the users.*

Break in program to accommodate time zones

SYSTEM INTEGRATION II

Session Chair: Takeshi Menjo, ISJ (Japan)
12 OCTOBER: 19:00 – 20:10 NEW YORK
13 OCTOBER: 00:00 – 01:10 LONDON / 08:00 – 09:10 TOKYO

Welcome Remarks, *Teruaki Mitsuya, Ricoh Company, Ltd. (Japan)*

19:10 (New York)
00:10 (London) / 08:10 (Tokyo)
Simulation of Inkjet Printing using Fluid Structural Interaction (FSI), *Dong Yeol Shin, Jae Min Jeon, Woo Jin Jeong, Hee Jung Kwak, and Jun Young Kim, Gyeongsang National University (Republic of Korea)* . . **A-20**
Because inkjet printing can form thin films through liquid-type materials regardless of simple process and substrate size, it can be used to develop Soluble OLEDs and QLED, which are actively researched for high-tech industries. During the inkjet printing process, the reliable drop of solutions is one of the important factors that determine the performance of display devices and the reliability of inkjet printing equipment. The stable solution drop requires research and understanding of solution property in this regard because it is affected by the physical properties of the solution and the magnitude and waveform of the voltage exerted on piezoelectric devices. In this work, we applied a Fluid Structural Interaction (FSI) method using Ansys Mechanical and Ansys Fluent to analyze the association of solution drop with the magnitude of the voltage applied to piezoelectric devices, the surface tension of the solution, and the change in the contact angle of the solution. This eliminates the hassle of measuring the speed profile through simulation that induced the shape of the piezoelectric device by electrical/physical properties of piezoelectric devices and voltages supplied to piezoelectric devices, rather than by inputting speed profiles or constant values. The solution used in this study is TFB (Poly (9,9-dioctylfluorenyl-2,7-diyl)-co-(4,4′-(N-(4-sec-butylphenyl) diphenylamine) with different molecular weights. Simulation shows that the input voltage for the stable drop was 15 [V], and the higher the surface tension of the solution, the more stable drop was possible by suppressing the formation of satellite liquid, and the contact angle of the solution did not significantly affect drop. In the actual phenomenon, the input voltage for stable drop was 35 [V]. In order to match the actual phenomenon, the calculation was performed by adding negative pressure to the nozzle inlet as a boundary condition. Various values were input as boundary conditions, and the most similar result to the actual phenomenon was -0.68 [atm]. However, this is only a finding of pressure similar to the actual result. Research on boundary conditions to obtain results similar to actual result needs to be continued.

19:25 (New York)
00:25 (London) / 08:25 (Tokyo)
Hardness Testing Process for Enhanced Joining, Material Validation, and Mass Serialization, *Katrina J. Weinmann and Steven J. Simske, Colorado State University (US)* **65**
In this paper, a method for the simultaneous provision of material validation, mass serialization, and binding enhancement using a portable hardness tester is presented for 3D printed parts. The process described in this paper is intended for implementation using a robotic arm-mounted hardness tester for ease of integration into a manufacturing environment, and adaptability of the process for custom parts. Hardness testing can be used for material validation, but the process of hardness testing leaves an indent in the material where the test is performed. Thus, the indents must be placed where they do not affect desired aesthetics, or else coupled with another desired process. By administering the hardness tests in a specified pattern on the material, the indents created on the material can be used for two additional functions – increasing the surface area to enhance joining, and marking an item-specific serialization code on the part that can be used for later identification. The post-processing of 3D printed parts can be streamlined by completing these three objectives in a single process that is highly adaptable to customized manufactured parts through an implementation using a robotic arm.

19:40 (New York)
00:40 (London) / 08:40 (Tokyo)
The Art of Gift-giving: Laser Cutting as a Value-added Technology for Fabricating Customized Biodegradable Packaging, *Shalida Mohd Rosnan and Toshiharu Enomae, University of Tsukuba (Japan)* **69**
It is a custom in certain cultures to send and exchange gifts for special occasions. This remarkable custom led to the idea of applying the laser cutting technology and using it as value-added to fulfill any custom shape of the packaging. Laser cutting applications in customized packaging can be helpful to be value-added to the digital printing system and reduce time consumption in the post-press rather than focused on die-cutting. Only the biodegradable substrate was used in this experiment. Rather than focusing on die-cutting, laser cutting is applied to reduce the hustle and reduce the post-press bottleneck. As a result, it is possible to produce more customized packaging in a short time. The laser cutting experiment was planned and conducted using a CO2 laser cutting machine. One of the laser cutting parameters, such as laser power, was tested in the experiment. The study also identified the parameter and optimal setting for the specific thickness of the paperboard. Also, subsequently, the optimum laser power was determined. The results showed that 50-60% laser power is the most significant ratio affecting the clean cuts of the specific thickness of materials.

19:55 (New York)
00:55 (London) / 08:55 (Tokyo)

Atomic Growing for Grid Alignment, *Yujian Xu[1], Matthew Gaubatz[2], Stephen Pollard[2], Robert Ulichney[1], and Jan Allebach[1]; [1]Purdue University and [2]HP Labs (US).* **73**

Detecting and aligning structured signals such as point grids plays a fundamental role in many signal processing applications. Joint determination of non-grid points and estimation of non-linear spatial distortions applied to the grid is a key challenge for grid alignment. This paper proposes a candidate solution. The method described herein starts from a small nearly regular region found in the point set and then expands the list of candidate points included in the grid. The proposed method was tested on geometrically transformed point sets and sets of locations derived from imagery of 3D prints. It is shown that a low-complexity grid alignment method can nonetheless achieve high grid alignment accuracy.

12 Oct: 20:10 – 20:35 (New York)
13 Oct: 01:10 – 01:35 (London) / 09:10 – 09:35 (Tokyo)
SESSION BREAK

Join the speakers and other attendees for informal discussions and networking.

SYSTEM INTEGRATION III

Session Chair: Hirotoshi Terao, ALPS ALPINE Co., Ltd. (Japan)
12 OCTOBER: 20:35 – 21:35 NEW YORK
13 OCTOBER: 01:35 – 02:35 LONDON / 09:35 – 10:35 TOKYO

20:35 (New York)
01:35 (London) / 09:35 (Tokyo)

JIST-FIRST SoftPrint: Investigating Haptic Softness Perception of 3D Printed Soft Object in FDM 3D Printers, *Motoki Miyoshi, Parinya Punpongsanon, Daisuke Iwai, and Kosuke Sato, Osaka University (Japan)* **78**

FDM 3D printers allow massive creativity in personal products, but their potential has been limited due to inability to manipulating material properties. Previous work had demonstrated that the desired roughness could be presented simply by controlling the spatial density of tiny pins on a printed surface. This article offers a means of providing the desired softness perception of a printed surface and the desired roughness to expand the haptic dimension over which a user can exert control. Specifically, we control the softness by manipulating the infill structures of a printed surface. However, it is known that a skin contact area affects softness perception. The roughness, which is controlled by pins' density, may also affect the perceived softness of a printed surface. Therefore, we investigate how the internal structures and the density of the pins affect softness perception. Through psychophysical experiments, we derive a computational model that estimates the perceived softness from the density of the pins and the infill density of a printed surface.

20:50 (New York)
01:50 (London) / 09:50 (Tokyo)

A Study on the Development of Coupling Simulation Technique for Predicting Toner Particle Leakage, *Yunki You[1], Jungro Seo[1], Cheol-O Ahn[2], Yooseok Kim[3], and Taehan Kim[1]; [1]HP Printing Korea Co., Ltd., [2]Metariver Technology Co., Ltd., and [3]TAESUNG S&E, INC. (Republic of Korea)* **86**

The distribution environment of printer products creates a lot of shocks. The shock causes a variety of malfunctions in the printer. Among them, toner leakage problem is the most difficult problem to solve. Multiple drop tests were conducted to find some causes of toner leakage. However, there are many limitations because toner particle size is too small.

In this study, to overcome these limitations and inefficiency of development process, the new simulation method is introduced. This method is developed for predicting toner leakage, and 1-way coupling analysis technology is used between structural analysis solver (LS-DYNA) and particle analysis solver (Metariver DEM) to make a toner leakage phenomenon visible.

21:05 (New York)
02:05 (London) / 10:05 (Tokyo)

Color Reproduction Study on the Corrugated Packaging using UV Wide-format Inkjet Printer, *Yu Ju Wu, Appalachian State University (US)* **92**

Packaging is one of the fastest growing segments in the print industry, specifically the digital packaging arena. Color digital printing for corrugated is essentially all inkjet and has existed for at least 20 years. High quality packaging prototyping allows for greater client choice and more short-run finished corrugated products. To exam the color reproduction capability on the corrugated packaging using UV wide-format inkjet printer, a Roland VersaUV LEJ-640 UV LED printer with Eco UV-curable inks was employed in this study. Four print settings were tested on the selected B-flute corrugated boards. The main purposes of this experimental study are to (1) identify the most important factors that influence color reproduction on the corrugated packaging using UV wide-format inkjet printing, (2) exam the process capability of tested print settings, and (3) establish optimum print setting so that the maximum yield of optical density and print contrast could be obtained. It was found that the use of white ink is the most important factor and has a significant effect on the optical density. The print setting of standard mode with white ink is suggested to achieve the maximum yield of optical density and print contrast.

21:20 (New York)
02:20 (London) / 10:20 (Tokyo)

Technologies that Support the New J Press 750SH, *Mamoru Shinohara, FUJIFILM Corporation (Japan)* **A-22**

The sheet-fed digital ink jet printer "J Press series" had achieved high image quality and color stability, then it has been well adopted in the printing market. In 2019, Fujifilm released J Press 750S with higher performance more than 30% keeping the same image quality. In 2021, Fujifilm plans to release an optional kit to upgrade J Press 750S to high-speed model. These technologies implemented in J Press 750S are reported.

12 Oct: 21:35 – 22:00 (New York)
13 Oct: 02:35 – 03:00 (London) / 10:35 – 11:00 (Tokyo)
SESSION BREAK

Join the speakers and other attendees for informal discussions and networking.

BEST OF ICAI: INVITED PAPERS FROM THE INTERNATIONAL CONFERENCE ON ADVANCED IMAGING

Session Chair: Nobuyiki Nakayama, FUJIFILM Business Innovation Corp. (Japan)

12 OCTOBER: 22:00 – 22:45 NEW YORK
13 OCTOBER: 03:00 – 03:45 LONDON / 11:00 – 11:45 TOKYO

22:00 (New York)
03:00 (London) / 11:00 (Tokyo)

Micro-patterning based on Optical Vortex Laser Induced Forward Transfer, *Muneaki Iwata[1, 2], Akihiro Kaneko[1, 2], and Takashige Omatsu[2]; [1]Ricoh Company, Ltd. and [2]Chiba University (Japan)* . . . **A-24**

We propose an entirely new printing system based on an optical vortex laser induced forward transfer (OV-LIFT) technology, which allows the production of microdroplets with a volume of ~25 pico-liter formed of an extremely high viscosity ink (viscosity: 4 Pa·s). The microdroplets are forwarded and printed as a dot with a diameter of ~75 μm on a receiver film.

22:15 (New York)
03:15 (London) / 11:15 (Tokyo)

Copper oxide (CuO) Fine Line Fabrication by Printing Method and Green Laser Sintering to Form Cu Conductive Line, *Md. Khalilur Rahma, Comilla University (Bangladesh); and Mosa Md Abu and Kye-Si Kwon, Soonchunhyang University (Republic of Korea)*. **A-28**

To prepare the nanofibers or nanowires, currently different materials are used in printed electronics applications, such as Au, Ag and Cu etc. Among other metal NPs, Ag NP ink has been employed most extensively because of its excellent electrical conductivity and oxidation stability. However, in recent decades the industry demands the low-cost materials for reliable application without sacrificing the quality of the devices. For this purpose, currently we used low-cost materials such as high viscous CuO NP ink to fabricate fine line by near field electrospinning method to connect two electrodes of glass substrate. In this research, we demonstrate that Cu conductive fine line can be fabricate using electrospinning method for printing the fine line and green laser for sintering.

22:30 (New York)
03:30 (London) / 11:30 (Tokyo)

Micropillar Surfaces for Generation of Three-dimensional Skin Models In Vitro, *Takahiro Kakegawa and Koji Fujimoto, Dai Nippon Printing Co., Ltd. (Japan)* **A-32**

Interest for alternative methods to animal testing is increasing, because of requirements for animal welfare. In vitro cell culture models are promising alternatives and three-dimensional skin models are commonly utilized as alternatives to human skin. Here, we developed a novel cell culture insert for generation of three-dimensional skin models. Bottom surface of the cell culture insert consists of micro-porous membrane film with micro-scale structures fabricated by photolithography, which mimic the surface undulating patterns of human skin. Three-dimensional skin models cultured using the novel cell culture insert showed increased thickness of 1.7-fold and 60% improvement of barrier function compared to skin models cultured on conventional flat surfaces. The novel cell culture insert could be a robust tool for generation of in vitro cell culture models.

LATE BREAKING NEWS: IMPACT OF COVID-19 ON INDUSTRIAL APPLICATIONS OF INKJET AND CURRENT STATUS

Session Chair: Masahiko Fujii, Keio University Institute at SFC (Japan)
Discussion Moderator: Atsushi Tomotake, Konica Minolta (Japan)

12 OCTOBER: 22:45 – 23:25 NEW YORK
13 OCTOBER: 03:45 – 04:25 LONDON / 11:45 – 12:25 TOKYO

10-minute presentations followed by a moderated discussion.

On-demand Thread Coloring Technology by Inkjet Printing, *Yoshiyuki Ishiyama, Ricoh Company, Ltd. (Japan)*

Impact of Covid-19 on the Textile Industry and the Current Status of Digital Textiles, *Koromo Shirota, Canon Inc. (Japan)*

The Promotion of Inkjet Applications Business, *Shotaro Watanabe, Seiko Epson (Japan)*

Closing Remarks
Printing for Fabrication General Chair Teruaki (Aki) Mitsuya, Ricoh Company, Ltd (Japan), and Technical Program Chair Ron Askeland, HP Emeritus Engineer with MBO Partners (US)