



IS&T

REPORTER

"THE WINDOW ON IMAGING"

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SELECTIONS FROM CONFERENCE PROCEEDINGS: DIGITAL FABRICATION 2007*

Ink Jet-Deposited Interconnections for Electronic Packaging

*Matti Mäntysalo and Pauliina Mansikkamäki,
Tampere University of Technology (Finland)*

Abstract: Ink jet technology provides an interesting approach for electronic manufacturing. Small volumes of functional material (e.g., conductive ink) are dispensed on top of the substrate. Electrical circuits are formed by suitable printing sequence and sintering processes. In this paper, we present a concept of ink jet deposited System-in-Package (SiP). The package contains bare ICs and discrete passive components that are encapsulated with resin mold. Encapsulation material works as a substrate for interconnections, which are directly deposited on top of the mold. All connections between the components and connections to the I/O pins are formed by ink jetting silver nanoparticle and dielectric inks. Silver nano-particles are sintered in an oven at 220°C and resistivity values lower than 5 $\mu\Omega$ cm are reported. Precuring of a substrate in a higher temperature than the sintering temperature of silver nano-particles, decreases the resistivity of the lines. As a conclusion, the sintering profile needs to be considered carefully in order to achieve resistance requirements set by the design. This paper focuses on interconnections and system integration design aspects.

Nanowire Placement with Ink Jet Heads

*K. A. Bertness, C. M. Dodson, P. T. Blanchard,
and N. A. Sanford, National Institute of Standards
and Technology; and Ross N. Mills, iTi Corporation (USA)*

Abstract: We have shown that thermal ink jet print heads can be used to place GaN nanowires on patterned substrates. The semiconductor nanowires had diameters ranging from 70 to 300 nm and lengths from 5 μ m to 20 μ m. They were dispersed in alcohol-water solutions for loading into ink reservoirs. To avoid clogging, the thermal ink jet heads were chosen with drop weights from 72 to 165 ng. The thermal ink jet method was successfully used to place nanowires across narrow gaps in metal patterns. When using a low-power optical microscope to align the nozzle with substrate pattern features, the placement accuracy is much higher than with micropipette placement. For unknown reasons, nanowires would not pass through piezoelectric ink jet heads. These experiments demonstrate that ink jet technology holds promise for low-cost, rapid, massively parallel placement and processing of nanowires for optoelectronic, electronic, and sensor applications.

*These papers were presented at Digital Fabrication 2007 held in Anchorage, Alaska, September 16–September 21.

To view full paper go to www.imaging.org/pubs/reporter/

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SELECTIONS FROM CONFERENCE PROCEEDINGS: NIP23*

Preparation of Polymer Microspheres by Phase-Separation/Aggregation (PSA) Technique for Color Toner Applications

Ming-Huei Liu, Fang-Yi Hsu, and Chen-Jen Yang,
Sinonar Corp. (Taiwan)

Abstract: A particle formation method related to controlled phase separation of organic and aqueous phases, and limited aggregation/coalescence is reported. The method can be applied effectively to form microspherical polymer particles for use as electrophotographic toners. An organic solution containing a polymer resin dissolved in a solvent and an aqueous phase containing an anti-aggregation agent are prepared. The aqueous solution is added to the organic solution during vigorous stirring to facilitate aggregation of gel colloids and diffusion of solvent into the aqueous phase due to the partial aqueous solubility of the solvent. As opposed to the case when the organic phase is added to the aqueous phase under an extremely high speed of agitation (>10,000 rpm), this phase-separation/aggregation process only requires an agitation speed of 1,000~1,500 rpm. Furthermore, removal of solvents due to diffusion into the aqueous phase is in process at the same time as the formation of gel particles. The depletion of solvents in the organic phase results in solid particle formation. Fine control of particle size distribution can be achieved by careful adjustments of the viscosity values of both the organic and the aqueous solutions. This phase-separation/aggregation method offers numerous advantages for preparation of toners including fast production run and extremely sharp particle size distribution, with mean volume-averaged diameter to mean number-averaged diameter ratios dv/dn smaller than 1.1. The particle shape can also be tuned by the selection of different aqueous solubilities of the solvents. Both styrene/acrylate based and polyester based materials can be applied for formation of microspherical particles by using the phase-separation/aggregation technique.

Novel Micro Piezo Technology for Ink Jet Printhead

Motonori Okumura and Tomoaki Takahashi,
Seiko Epson Corporation (Japan)

Abstract: Micro Piezo technology is offering superior features in ink ejection performance, compatibility with a wide variety of inks, and durability. As a result, this technology has already being utilized effectively in various commercial and industrial fields such as photo lab printing, digital printing, textile printing, and color filter manufacturing. However, new printheads that have a larger number of nozzles and higher performance are constantly required to improve

printing speed or productivity, both for commercial products and industrial applications. We have succeeded to develop a next-generation Micro Piezo printhead, which has 360 nozzles-per-inch and piezo elements of one micrometer of thickness. In spite of the nozzle density doubled, this printhead retains all the advantages of the current Micro Piezo printheads, including the ability to produce variable sized droplets and the capability to eject ink droplets at high frequency. The installation of next-generation Micro Piezo printheads in printers and other devices will make it possible to design speedier and more compact ink jet equipments than ever before. In this paper, the key to improve the printhead performance and increasing nozzle density is studied. Then, the structure and characteristics of the next-generation Micro Piezo printhead are described.

Advances in Digital Imaging for Fine Art and Cultural Heritage

D. John Redman, Hewlett-Packard Company, and
Mark Mudge, Cultural Heritage Imaging (USA)

Abstract: Digital imaging techniques have been applied to fine art and cultural heritage for decades. Due to continuing advances in technology and increases in funding, the application of digital imaging and digital reproduction to fine art and cultural heritage has recently exploded. To simplify the discussion of digital fine art, this paper will subdivide digital imaging into five segments: digital image capture; archiving; conservation; restoration; and reproduction. The Hewlett-Packard Company, Cultural Heritage Imaging, and the Rochester Institute of Technology have each been major participants in this digital imaging explosion. The author is familiar with many of the activities of these three institutions. Taken together, their activities form a storyboard of where digital fine art maybe headed. By way of example, the results of specific projects will be discussed. Advances in digital image capture include hyperspectral imaging and reflection transformation imaging and their use at the Worcester Art Museum. A striking innovation in archiving and conservation is demonstrated by the Kyoto International Culture Foundation shrine art conservation project. The rejuvenation simulation of a Seurat painting and the physical restoration of the vault at the Santos Juanes Church demonstrate amazing progress in the field of digital restoration. Finally, the Grand Tour in London is a great illustration of how digital fine art reproduction can involve the public in their cultural heritage.

*These papers were presented at NIP23rd: International Conference on Digital Printing Technologies held in Anchorage, Alaska, September 16–September 21.

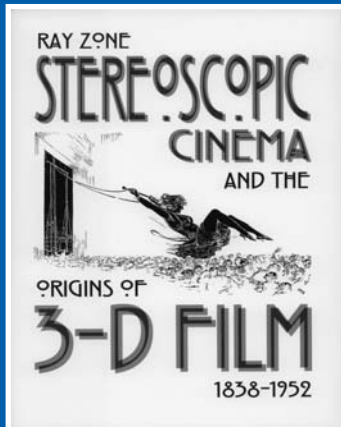
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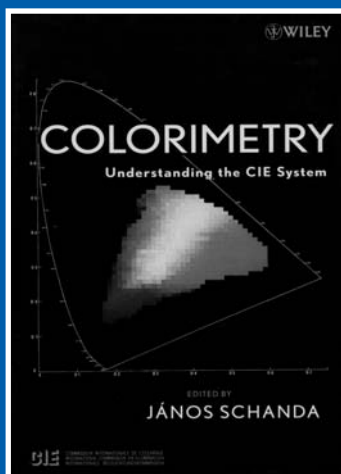


Stereoscopic Cinema and the Origins of 3-D Film 1838-1952

Ray Zone; published by The University Press of Kentucky, 2007, 220 pp., ISBN: 978-0-8131-2461-2, 1 lbs.

Stereoscopic Cinema and the Origins of 3-D Film, 1838-1952 is an exhaustive study of the evolution of 3-D technology and subsequent filmmaking achievements, as well as the public response to and cultural impact of 3-D movies. Zone takes the reader on a voyage of discovery into the rich history of a field that predates photography and that continues to influence television and computer animation today.

Special / Member and Non-Member: \$35 (list price \$42.00)



Colorimetry—Understanding the CIE System

Edited by János Schanda, published by John Wiley and Sons, Inc. 2007, 459 pp., ISBN: 978-0-470-04904-4, 1.7 lbs.

Since 1931, the CIE (the International Commission on Illumination, abbreviated as CIE from the original French, Commission Internationale de l'Éclairage) has set colorimetric standards and procedures that are now integral in performing laboratory and industrial color measurements. Over the past years, the CIE has periodically issued updates and further recommendations regarding colorimetry; this book compiles this information in one practical, comprehensive resource. This is the single-source, hands-on reference for color and vision scientists, industrial color engineers, and lighting and optical engineers. It is also an excellent textbook for upper-level undergraduate or graduate courses dealing with colorimetry.

Members: \$98 / Non-Members: \$105 (list price \$115.00)



Color Constancy

Marc Ebner, published by John Wiley and Sons, Inc. 2007, 416 pp., ISBN: 978-0-470-05829-9, 2 lbs.

A human observer is able to recognize the color of objects irrespective of the light used to illuminate them. This is called color constancy. A digital camera uses a sensor to measure the reflected light, meaning that, the measured color at each pixel varies according to the color of the illuminant. Therefore, the resulting colors may not be the same as the colors that were perceived by the observer. Obtaining color constant descriptors from image pixels is not only important for digital photography, but also valuable for computer vision., color-based automatic object recognition, and color image processing in general. This book provides a comprehensive introduction to the field of color constancy, describing all the major color constancy algorithms, as well as presenting cutting edge research in the area of color image processing.

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STANDARDS UPDATE

David Q. McDowell, Editor

Every year I do several articles that predict what will happen in the area of graphic arts standards over the upcoming year. It seemed appropriate to borrow from these articles and provide such a summary for the *IS&T Reporter*.

The graphic arts standards outlook for 2008 is very much a continuation of the work started in 2007. There are many ongoing activities, some new activities, but nothing earth-shattering or spectacular. In preparing this summary I was struck by the fact that standards in the graphic arts industry are no longer something new or unusual. 2008 is the 40th anniversary of the initial creation of ISO TC130 and the 19th anniversary of its reactivation. In the United States, graphic arts standards became an issue in the 1982–1983 time frame—that’s 25 years ago. So I guess it’s OK that standards continue to be a “work in progress.” (B65, the ANSI graphic arts safety committee, was accredited by ANSI in 1983, and CGATS was accredited 1989.)

NPES continues to provide administrative support of the CGATS, B65, and the US TAG to TC130 standards activities and is accredited by the American National Standards Institute (ANSI) in these roles. More information is available at www.npes.org/standards/workroom.html from Mary Abbott at mabbott@npes.org, or from the author.

Let’s look at some of the more important achievements in graphic arts standards during 2007 and what we expect to see in 2008. We as an industry have become more diverse and therefore standards activities beyond ISO TC130, ANSI CGATS, and ANSI B65 impact us. I will note some of these other activities that may have significant impact on printing and publishing.

File Formats

The ISO-defined PDF/X file formats are the dominant format for exchange of graphic arts content data and their use, and impact,

continues to increase. However, TIFF/IT continues to be viable in many parts of the world and PPML/VDX is becoming significant for variable data printing.

PDF/X

The family of PDF/X standards, published in late 2003, continue to be the workhorses of data exchange. These are:

- ISO 15930-4:2003, *Graphic technology—Prepress digital data exchange using PDF—Part 4: Complete exchange of CMYK and spot colour printing data using PDF 1.4 (PDF/X-1a)*
- ISO 15930-5:2003, *Graphic technology—Prepress digital data exchange using PDF—Part 5: Partial exchange of printing data using PDF 1.4 (PDF/X 2)*
- ISO 15930-6:2003, *Graphic technology—Prepress digital data exchange using PDF—Part 6: Complete exchange of printing data suitable for colour-managed workflows using PDF 1.4 (PDF/X-3)*

Two new parts of the PDF/X family have been completed and will be published in early 2008. These are:

- ISO 15930-7, *Graphic technology—Prepress digital data exchange using PDF—Part 7: Complete exchange of printing data (PDF/X-4) and partial exchange of printing data with external profile reference (PDF/X-4p) using PDF 1.6*
- ISO 15930-8, *Graphic technology—Prepress digital data exchange using PDF—Part 8: Partial exchange of printing data using PDF 1.6 (PDF/X-5).*

PDF/X-5 has three conformance levels: PDF/X-5g which allows external graphical content; PDF/X-5n which enables ICC profiles for n-colorant print characterizations to be referenced; and PDF/X-5pg which combines external graphical content and externally-referenced output-intent ICC profiles.

The International Color Consortium (ICC) characterization data registry, which is used as the primary pointer for the intended printing conditions for a PDF/X file, has been expanded to include

a Profile Registry to facilitate the external referencing of profiles as allowed in PDF/X-4 and PDF/X-5. This is reachable through the ICC website, www.color.org. Although the standards do not require use of the ICC profile registry, it is believed that use of a common profile registry will not only facilitate the use of PDF/X-4 and PDF/X-5 but will also help make profiles readily available for broader use.

TIFF/IT

TIFF/IT is still important for the exchange of data in some areas of the world. The most recent amendment to ISO 12639:2004, *Graphic technology—Prepress digital data exchange—Tag image file format for image technology (TIFF/IT)* was published in 2006. Although no other work is currently planned for this standard it was reconfirmed by TC130 in 2007.

PPML/VDX

The PPML/VDX file format, ISO 16612-1, *Graphic technology—Variable printing data exchange—Part 1: Using PPML 2.1 and PDF 1.4 (PPML/VDX-2005)* was published in 2005.

During 2007 work was started on Part 2 with a preliminary title of ISO 16612-2, *Graphic technology—Variable data exchange—Part 2: Using PDF/X-4 and PDF/X-5 (vPDF-1:200x)*. It is based on PDF 1.6 as restricted by PDF/X-4 and PDF/X-5, and is designed to enable variable document printing in a variety of environments from desktop printers to digital production presses. It does not provide for the transmission of process control information but is constructed to enable its use with JDF or a similar job ticket format.

The present trend towards the separation of variable document content creation from the details of print production workflow and printing device dependencies is evolving rapidly. CIP4’s JDF job ticket specification is the job ticket format of choice for specifying

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the definition of a print product and corresponding production process in a way that is independent of any particular graphical content format.

Like PDF/X, this standard will enable the exchange of content, where no additional technical information is required to be communicated between sender and receiver.

PDF/A

ISO 19005-1, *Document management—Electronic document file format for long-term preservation—Part 1: Use of PDF 1.4 (PDF/A)* published in December 2005, is gaining wide acceptance for the archival storage of documents in electronic form. It was created by a Joint Working Group (JWG5-PDF/A) formed under ISO TC171/SC2 (Document management applications/Application issues) and includes representatives of ISO TC 171/SC 2, ISO TC 42 (Photography), ISO TC 46/SC11 (Info-

mation and documentation/Archives records management), and ISO TC130 (Graphic technology).

PDF

In January 2007 Adobe Systems announced that it would work with AIIM (Association for Information and Image Management) and ISO TC 171 to make PDF 1.7 an ISO standard. In July the PDF 1.7 Reference, converted to follow ISO template and styling rules, was sent out for ballot as a Fast Track DIS as ISO 32000, *Document management—Portable document format—PDF 1.7*.

The ballot closed on December 2, 2007 and was approved. A new JWG is being formed within ISO TC 171, and TC130 has requested to be part of this activity. It is this group that will be responsible for future definition of PDF and work has already been started to identify new features that are desirable to be included in the next version.

XPS

Ecma International has recently created a new technical committee, TC 46, to work on standardization of the XML Paper Specification (XPS). The goal of the Technical Committee is to produce a formal standard for an XML-based electronic paper format and XML-based page description language which is consistent with existing implementations of the format called the *XML Paper Specification (XPS)*.

XPS is a document storage and viewing specification developed by Microsoft that is intended to describe electronic paper in a way that it can be read by hardware, software and the human eye. XPS is intended to provide a page view of the way the document will print. It will describe the appearance of fixed format documents by using an XML based format so that the layout won't change. It is a key component of the Microsoft Vista Office Suite

A formal liaison has been established

between Ecma TC46 and ISO TC130 to allow graphic arts interaction with, and input to, this activity.

Printing Condition Definition

As we have said many times, meaningful data exchange is dependant on a clear definition of the intended color appearance of the content data being transmitted. The mechanisms used to convey the intend color appearance are pointers to characterization data and/or ICC profiles based on such characterization data. The use of the ICC Characterization Registry (www.color.org/registry2.html) has become the accepted reference for characterization data. Most of the characterization data posted on the ICC website, and other references, is based on the ISO 12647 series of standards. During 2007, this website has been expanded to also include an ICC Profile Registry which is required to support the new PDF/X-4 and PDF/X-5 standards.

Printing Aims and Characterization Data

CGATS, working with the various industry groups has completed and published the following Technical Reports documenting characterization data which has been posted to the ICC registry and forms the basis for ICC profiles.

- CGATS/SNAP TR 002-2007, *Graphic technology—Color characterization data for coldest printing on newsprint*
- CGATS/SWOP TR 003-2007, *Graphic technology—Color characterization data for SWOP® proofing and printing on U.S. Grade 3 coated publication paper*
- CGATS/SWOP TR 005-2007, *Graphic technology—Color characterization data for SWOP® proofing and printing on U.S. Grade 5 coated publication paper*
- CGATS/GRACoL TR 006-2007, *Graphic technology—Color characterization data for GRACoL® proofing and printing on U.S. Grade 1 coated paper*

ISO 12647-7, *Graphic technology—Process control for the manufacture of half-tone colour separations, proof and productions prints—Part 7: Off-press proofing process working directly from dig-*

ital data, was approved at the DIS stage. However, there was one negative vote accompanied by a request to include provisions for design proofs in addition to contact proofs. This has resulted in extensive discussion in TC130 and the decision to proceed with the FDIS ballot of ISO 12647-7 without provision for design proofs. However, it was agreed to start an immediate revision to create a new document that will include this distinction.

Discussions of both “CMYK exchange color spaces” and “paper characterization” are ongoing in the ICC and in TC130. In TC130, work on the Technical Specification *Graphic technology—Method for calibration of a printing system with digital data*—continues and is related to the potential development of print-process-independent CMYK exchange color spaces. Discussions have been initiated between ISO TC 6 (Paper) and TC130 to begin reviewing issues of paper characterization. It is well recognized that paper is a critical component in all process color printing. It is not only the “fifth colo” but its characteristics also determine both the appearance of and the amount of ink that can be printed.

ICC Color Management

The ICC work on a coordinated revision of both ICC.1 and ISO 15076:2005 (*Image technology colour management—Architecture, profile format, and data structure—Part 1: Based on ICC.1:2004-10*) is progressing. The major task of updating the current ISO document to better match the ISO editing criteria (we were given a waiver from ISO on many items in the current version) is almost complete. The approved changes will then be incorporated and the document will be circulated for simultaneous approval in the ICC and TC130.

The decision was made by the ICC Steering Committee that, because the current changes are classified as an ICC minor revision, the current version will be revised and the additions/changes identified in an informative annex. The

alternative would have been to prepare the new version as a Part 2 of ISO 15076.

Color Data Space

Closely related to the issues of color content data is the issue of color data space definition. A new work item has been approved in TC 42/JWG 22 (Joint with TC130) to develop a Part 4 of ISO 22028. The proposed title is *Photography and graphic technology—Extended colour encodings for digital image storage, manipulation, and interchange—Part 4: European Colour Initiative RGB colour image encoding (eciRGB (2008))*. Work will be started on this standard in 2008.

Test Images

ISO 12640-3:2007, *Graphic technology—Prepress digital data exchange—Part 3: CIELAB standard colour image data (CIELAB/SCID)* was published in 2007.

IS&T REPORTER

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This standard adds a third set of standard images to ISO 12640 which are encoded as CIELAB data and provides a large gamut reference image set. This standard also documents a reference color gamut that encompasses the known range of real world surface colors. This same gamut has been defined by the ICC as the gamut of the perceptual rendering intent reference medium.

Metrology and Viewing Standards

Two key standards that play a pivotal role in the digital data exchange and color management arena are under revision. These are ISO 3664:2000, *Viewing conditions—Graphic technology and photography*, and ISO 13655:1996, *Graphic technology—Spectral measurement and colorimetric computation for graphic arts images*.

The revision of ISO 3664 is well underway in TC42/JWG24 (a joint working group involving representatives of both TC42 and TC130). The CD draft was

approved, comments resolved and a DIS draft is in preparation.

The revision of ISO 13655 is also progressing rapidly in TC130/JWG8 (also a joint working group involving both TC42 and TC130). The DIS is in ballot with a closure date of March 23, 2008.

ISO 12646:2004, *Graphic technology—Displays for colour proofing—Characteristics and viewing conditions*, although recently published, was revised to include, and take into account, the characteristics of flat panel displays. It has been approved and is at ISO Central Secretariat (ISOCS) for publication (hopefully early in 2008).

CIE Colorimetry Standards

CIE is in the process of developing a new CIE Standard, CIE S 014 *Colorimetry*. This is a multi-part standard where the individual parts are as follows:

- Part 1: CIE standard colorimetric observers
- Part 2: CIE standard illuminants
- Part 3: Part 3: CIE tristimulus values
- Part 4: CIE 1976 $L^*a^*b^*$ colour space

- Part 5: CIE 1976 $L^*U^*V^*$ colour space

The intent is that these will have joint ISO/CIE designations. Parts 1, 2 and 4 have already been published and are available from CIE. Parts 3 and 5 are being prepared by TC 2-57 based on existing ISO/CIE standards.

For suggestions for (or input to) future updates, or standards questions in general, please contact the author at mcdowell@npes.org or mcdowell@kodak.com.

Need summer help?

Imaging and Photographic Technology Coop opportunities during the coming summer months are being sought by students enrolled at RIT.

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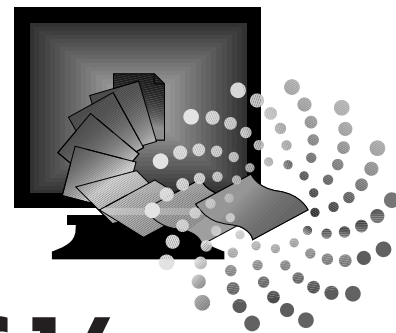
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www.imaging.org/conferences/CIC16/

UPCOMING EVENTS

May 31, 2008; Münster, Germany
Frontiers in Digital Imaging: Münster
General Chair: Reinhard Baumann

June 9–13, 2008; Terrassa, Spain
CGIV 2008: IS&T Fourth European Conference on Color in Graphics, Imaging, and Vision
General Chair: Jaume Pujol

June 24–27, 2008; Bern, Switzerland
Archiving 2008
General Chair: Rudolf Gschwind

June 25–June 27, 2008; Tokyo, Japan
PPIC '08: Pan-Pacific Imaging Conference 2008
General Chair: Takashi Kitamura

September 7–12, 2008; Pittsburgh, Pennsylvania
Digital Fabrication 2008
General Chair: Ross Mills
NIP24: 24th International Conference on Digital Printing Technologies
General Chair: Detlef Schulze-Hagenest

January 18–22, 2009; San Jose, California
Electronic Imaging 2009
General Chairs: Nitin Sampat and Jan Allebach

Feb 28–March 1, 2009; Las Vegas
Technologies in Digital Photo Fulfillment
General Chair: Stuart Gordon

OTHER MEETINGS

April 7–11, 2008
Optical and Digital Image Processing (EPE115)
Sponsored by: SPIE Europe; <http://spie.org/photronics-europe.xml>

April 8–10, 2008
PhotoWorld-Dubai 2008
www.photoworld-dubai.com

April 28–2, 2008
ASPR 2008 Annual Conference, Bridging the Horizons: New Frontiers in Geospatial Collaboration
Sponsored by: ASPRS; www.asprs.org/portland08

May 18–23, 2008
Display Week 2008: The SID International Symposium, Seminar & Exhibition
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May 28–30, 2008
2008 International Congress on Image and Signal Processing (CISP 2008)
Sponsored by: Hainan Normal University; www.hainu.edu.cn/CISP2008

June 4–6, 2008
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