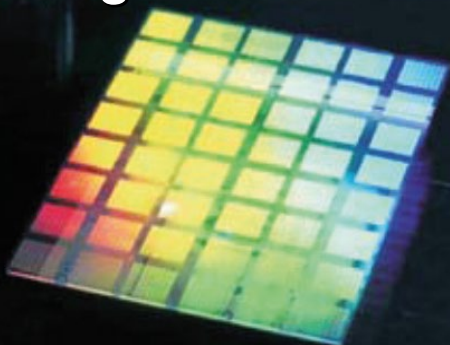


Program



The 37th European
Mask and Lithography
Conference

EMLC 2022

June 20 – 23, 2022
KU Leuven, Belgium

www.emlc-conference.com



VDE

VDI

GMM

Welcome to the EMLC 2022 in Leuven

On behalf of the VDE/VDI/GMM Society, the EMLC 2022 Sponsors and the EMLC 2022 Organization Committee we would like to welcome you to the 37th European Mask and Lithography Conference, EMLC 2022, at the KU in Leuven, Belgium.

The conference annually brings together scientists, researchers, engineers and technicians from research institutes and companies from around the world to present their latest findings in mask and lithography techniques. The EMLC 2022 conference is dedicated to research, technology and related processes. It provides an overview of the current state of mask and lithography technologies and future strategy. Here, mask manufacturers and users have the opportunity to familiarize themselves with the latest developments and results.

Get Together on Monday evening 7:00 – 08:00 pm

Join us at the Jubilee Hall on the first day of the conference!

Conference Dinner Banquet

On Tuesday evening, June 21st, 2022 after the Poster Session, the EMLC 2022 Conference Dinner will take place at the **“Faculty Club” in Leuven** (within ten minutes’ walk from the conference site).

Belgian Beer Farewell on Wednesday 17:45 – 19:00

IMEC in Leuven invites the EMLC participants to **visit IMEC on Thursday morning, June 23rd, 2022, after the conference.**

A bus will take the signed people (maximum 50 participants) to the IMEC facility. The tour will start at 09:40 AM from the Faculty Club where we had dinner on Tuesday.

Uwe Behringer

EMLC2022 Conference Chair

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The EMLC 2022 International Program Committee

Conference Chairs

Behringer, Uwe, UBC Microelectronics, Ammerbuch, Germany

Finders, Jo, ASML, Veldhoven, The Netherlands

Co-Conference Chairs

Connolly, Brid, Toppan Photomasks GmbH, Dresden, Germany

Gale, Chris, Applied Materials, Dresden, Germany

Hayashi, Naoya, DNP, Saitama, Japan

Program Chairs

Stolberg, Ines, Vistec Electron Beam, Jena, Germany

Erdmann, Andreas, Fraunhofer IISB, Erlangen, Germany

Loeschner, Hans, IMS Nanofabrication, Vienna, Austria

Co-Program Chairs

Peters, Jan Hendrik, bmbg Consult Radebeul, Germany

Sarlette, Daniel, Infineon, Dresden, Germany

Other Members

Born, René, Photronics MZD GmbH, Dresden Germany

Ehrmann, Albrecht, Carl Zeiss SMT GmbH, Oberkochen, Germany

Hoya Farrar, Dave, HOYA Corporation, London, UK

Galler, Reinhard, EQUIcon Software GmbH, Jena, Germany

Le Gratiet, Bertrand, ST Microelectronics, Crolles, France

Levinson, Harry J., HJL Lithography, Saratoga, CA, USA

Muehlberger, Michael, Profactor GmbH, Steyr-Gleink, Austria

Pain, Laurent, CEA-Leti, Grenoble, France

Ronse, Kurt, IMEC, Leuven, Belgium

Savari, Serap, Texas A&M University College Station, USA

Scheruebl, Thomas, Carl Zeiss SMT GmbH, Jena, Germany

Schnabel, Ronald, VDE/VDI-GMM, Frankfurt, Germany

Schulze, Steffen, Siemens EDA

Seltmann, Rolf, Dresden, Germany

Tschinkl, Martin, Toppan Photomasks Germany GmbH, Dresden, Germany

Waelpoel, Jacques, ASML, Veldhoven The Netherlands

Wiley, Jim, Santa Clara, CA, USA

Wurm, Stefan, ATICE LLC, Albany, NY, USA

Yoshitake, Shusuke, NuFlare, Japan

Zurbrick, Larry, Keysight Technologies, Santa Clara, CA, USA

Organizers

VDE/VDI-Society Microelectronics Microsystems and Precision Engineering (GMM)

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72119 Ammerbuch, Germany

Phone: +49-171-455-3196
Fax: +49-7073-50216
e-Mail: uwe.behringer.ubc@t-online.de

14:00 - 16:15

EMLC 2022 TUTORIAL Session14:00 - 14:05 **Welcome**

*Uwe Behringer / UBC Microelectronics,
Ammerbuch (Germany)
EMLC 2022 Conference Chair*

1st TUTORIAL:14:05 - 15:10 **Stochastic effects in lithography:
the ultimate resolution limit?**

*Peter De Bisschop / IMEC, Leuven (Belgium)
Chair: Kurt Ronse / IMEC, Leuven (Belgium)*

2nd TUTORIAL:15:10 - 16:15 **Synergy between Quantum Computing
and Semiconductor Technology**

*Rogier Verberk et al. / TNO, Delft
(The Netherlands)*

*Chair: Jo Finders / ASML, Veldhoven
(The Netherlands)*

16:15 - 16:45 Coffee Break is sponsored by
**Advanced Mask Technology Center,
AMTC**

16:45 - 18:45

Session “M”: Student Presentations - 1*Chair: Reinhard Galler / EQUIcon (Germany)**Co-Chair: René Born / Photonics (Germany)***16:45 - 17:05 3D mask defect and repair simulation based on SEM images***Vlad Medvedev et al. / Fraunhofer IISB, Erlangen (Germany)**+ Poster Presentation in Session 7***17:05 - 17:25 Transfer learning for deep learning EUV simulation models***Abdalaziz Awad / Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany)**+ Poster Presentation in Session 7***17:25 - 17:45 Optimizing EUV Imaging Metrics as a Function of Absorber Thickness and Illumination Source: Simulation Case Study of Ta-Co alloys***Devesh Thakare et al. / IMEC and KU Leuven, Leuven (Belgium)**+ Poster Presentation in Session 7***17:45 - 18:05 Mask variability with extraction of SEM image contour and area measurements***Matthieu Piloto / ST Microelectronics, Crolles (France)***18:05 - 18:25 Contour based on-device overlay metrology assessment using synthetic SEM images***Thibaut Bourguignon et al. / ST Microelectronics, Crolles, and University Grenoble Alpes, CEA-Leti, Grenoble (France)**+ Poster Presentation in Session 7*

18:25 - 18:45 **Application of the “three-state lithography model” for grayscale lithography**

Bassem Badawi et al. / Fraunhofer EMFT, Munich (Germany)

+ Poster Presentation in Session 7

19:00 - 20:00

EMLC 2022 Get Together

*is sponsored by **JSR Micro***

The EMLC 2022 Get Together takes place in the Jubilee Hall of KU Leuven



© KU Leuven

The KU Leuven Jubilee Hall is also the place for the EMLC 2022 Exhibition and Poster Session, as well as for Coffee and Lunch Breaks

09:00 - 09:15 **Welcome and Introduction**
*Uwe Behringer / UBC Microelectronics,
Ammerbuch (Germany)
EMLC 2022 Conference Chair*

09:15 - 10:35

Session 1: 1st PLENARY

*Chair: Stefan Wurm / ATICE LLC (USA)
Co-Chair: Ines Stolberg / Vistec (Germany)*

KEYNOTE

09:15 - 09:55 **The endless progression of Moore's law**
Luc Van Den Hove / IMEC, Leuven, Belgium

KEYNOTE

09:55 - 10:35 **Photomask Challenges for Upcoming Technology Nodes**
Frank E. Abboud / Intel Corporation, Santa Clara (USA)

10:35 - 11:00 Coffee Break is sponsored by
HEIDELBERG INSTRUMENTS

11:00 - 11:40

Session 2: 2nd PLENARY

*Chair: Brid Connolly / TOPPAN (Germany)
Co-Chair: Temitope Onanuga / Infineon (Germany)*

KEYNOTE

11:00 - 11:40 **EUV Lithography: past, present and future**
Jos P.H. Benschop / ASML, Veldhoven (The Netherlands)

11:45 - 12:35

Session 3: 3rd PLENARY*Chair: Laurent Pain / CEA-Leti (France)**Co-Chair: Ines Stolberg / Vistec (Germany)***PLENARY**11:45 - 12:10 **What's Next in Computing – From Bits to Qubits***Heike Riel / IBM Research, Rüschlikon
(Switzerland)***PLENARY**12:10 - 12:35 **Worldwide non-EUV photolithography equipment market***Taguhi Yeghoyan / YOLE Développement,
Lyon (France)***12:35 - 14:00 Lunch Break** is sponsored by
VISTEC ELECTRON BEAM

14:00 - 15:35

Session 4: EUV Lithography*Chair: Jo Finders / ASML (The Netherlands)**Co-Chair: Albrecht Ehrmann / Carl Zeiss SMT (Germany)***INVITED**14:00 - 14:25 **Imaging (enhancement) in EUV lithography: current status and future resolution enhancement techniques***Jo Finders / ASML, Veldhoven
(The Netherlands)***INVITED**14:25 - 14:50 **EUV Lithography Optics: Current Status and Future Developments***Dirk Hellweg / Carl Zeiss SMT, Oberkochen
(Germany)***INVITED**14:50 - 15:15 **EUV masks: status and outlook***Vicky Philippsen et al. / IMEC, Leuven (Belgium)*

15:15 - 15:35 **Spatial frequency breakdown of CD variation**

Tatiana Kovalevich et al. / IMEC, Leuven (Belgium)

15:35 - 16:00 Coffee Break is sponsored by
SIEMENS and POZZETTA

16:00 - 17:30

Session 5: Student Presentations - 2

Chair: Andreas Erdmann / Fraunhofer IISB (Germany)

Co-Chair: Thomas Scheruebl / Carl Zeiss SMT (Israel)

INVITED

16:00 - 16:25 ZEISS Award for Talent in the Industry –
1st Place at SPIE Photomask Technology 2021

Statistical analysis of the impact of 2D reticle variability on wafer variability in advanced EUV nodes using large-scale Monte Carlo simulations

Luke T. Long et al. / University of California Berkeley, CA (USA)

INVITED

16:25 - 16:50 Photonics Student Award – 1st Place at SPIE Photomask Technology 2021

Pathfinding the perfect EUV mask: understanding the EUV mask using the hybrid mask model

Hazem Mesilhy et al. / Fraunhofer IISB, Erlangen (Germany)

16:50 - 17:10 **Predicting DUV open contact risk with scarce sampling using new contour-based metric**

Elvire Soltani et al. / STMicroelectronics, Crolles (France)

+ Poster Presentation in Session 7

17:10 - 17:30 **Lithographic Performance of Resist
ma-N 1402 in an Ebeam/iline Stepper
Intra-level Mix and Match Approach**

*Cansu Hanim Canpolat-Schmidt et al. /
Fraunhofer ENAS / Chemnitz University of
Technology, Chemnitz (Germany)*

17:35 - 18:15

Session 6: 4th PLENARY

Chair: Ines Stolberg / Vistec (Germany)

Co-Chair: Hans Loeschner / IMS Nanofabrication (Austria)

KEYNOTE

17:35 - 18:15 **Material processing & metrology for
CMOS and qubits are more alike than
you think**

Rogier Verberk / TNO, Delft (The Netherlands)

18:15 - 19:15

Session 7: Poster Session

Chair: Reinhard Galler / EQUIcon (Germany)

Co-Chair: Hans Loeschner / IMS Nanofabrication (Austria)

P-1 **In-line Airborne Particle Sensing – A Streamlined
Contamination Solution for Cleanroom Environ-
ments**

*Vidya Vijay and Shawn Malek et al. / CyberOptics,
Minneapolis (USA)*

P-2 **Holistic imaging for yield improvements enab-
led by high-availability, and low-environmental
impact Cymer ArFi lightsource**

*Natallia Karlitskaya, Thomas Yang, David Manley,
Peter Oh, Yingbo Zhao, Rajasekhar Rao, Marc Sells,
Josh Thornes, James Bonafede, Will Conley / ASML
– Cymer Light Sources, San Diego (USA) / Cymer, an
ASML Company, Minneapolis (USA)*

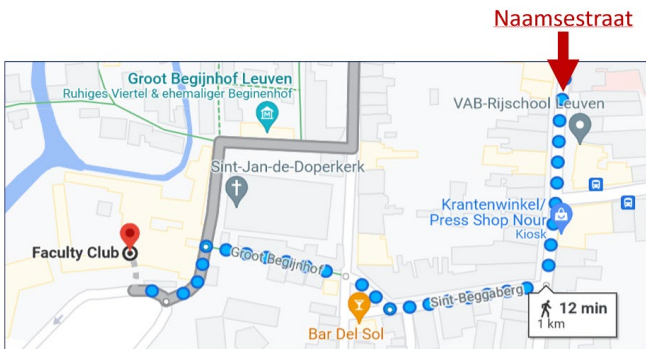
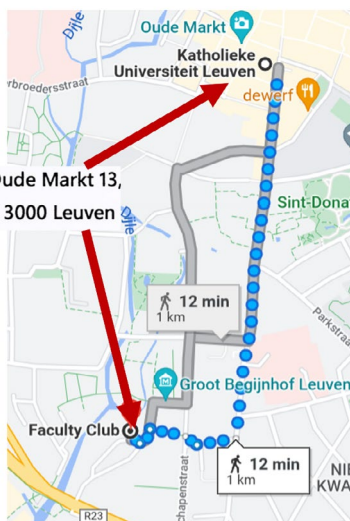
Student Posters

- StP-1 **Application of the “three-state lithography model” for grayscale lithography**
Bassem Badawi et al. / Fraunhofer EMFT, Munich (Germany)
- StP-2 **Optimizing EUV Imaging Metrics as a Function of Absorber Thickness and Illumination Source: Simulation Case Study of Ta-Co alloys**
Devesh Thakare et al. / IMEC and KU Leuven, Leuven (Belgium)
- StP-3 **3D mask defect and repair simulation based on SEM images**
Vlad Medvedev et al. / Fraunhofer IISB, Erlangen (Germany)
- StP-4 **Lithographic Performance of Resist ma-N 1402 in an Ebeam/iline Stepper Intra-level Mix and Match Approach**
Cansu Hanim Canpolat-Schmidt et al. / Fraunhofer ENAS / Chemnitz University of Technology, Chemnitz (Germany)
- StP-5 **Transfer learning for deep learning EUV simulation models**
Abdalaziz Awad / Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany)
- StP-6 **Contour based on-device overlay metrology assessment using synthetic SEM images**
Thibaut Bourguignon et al. / ST Microelectronics, Crolles, and University Grenoble Alpes, CEA-Leti, Grenoble (France)
- StP-7 **Predicting DUV open contact risk with scarce sampling using new contour-based metric**
Elvire Soltani et al. / STMicroelectronics, Crolles (France)

19:15 - 19:30 **ca 12 min walk to Dinner site**

**How to go to
Faculty Club (FC)
12 min walk
from KU Leuven**

Katholieke Universiteit Leuven, Oude Markt 13,
Faculty Club, Groot Begijnhof 14, 3000 Leuven



19:30 – 22:00

EMLC 2022 Conference Dinner at Faculty Club

*is sponsored by **HOYA and CARL ZEISS***

09:00 - 10:35

Session 8: Mask Patterning, Metrology and Process*Chair: Martin Tschinkl / TOPPAN Europe (Germany)**Co-Chair: Jan Hendrik Peters / BMBG (Germany)***INVITED**09:00 - 09:25 **Mask making 4.0***Thomas Schmidt / AMTC – Advanced Mask Technology Center, Dresden (Germany)***INVITED**09:25 - 09:50 **New registration calibration strategies for MBMW tools by PROVE measurements***Michael Haberler et al. / IMS Nanofabrication, Brunn am Gebirge and Vienna (Austria)***INVITED**09:50 - 10:15 **A storytelling of mask management in an advanced wafer fab***Frank Sundermann / ST Microelectronics, Crolles (France)*10:15 - 10:35 **Accuracy improvement of contour measurement for a shadow phenomenon of Mask CD-SEM image***Iwai Toshimichi and Soichi Shida / Advantest, Chiyoda (Japan) Soichi Shida / Advantest Corporation***10:35 - 11:00 Coffee Break** is sponsored by
TOPPAN PHOTOMASKS

11:00 - 12:30

Session 9: Data Analytics in Manufacturing*Chair: Bertrand Le-Gratiet / STMicroelectronics (France)**Co-Chair: Serap Savari / Texas A&M University (USA)*

PANEL on IMAGE COMPUTING in MANUFACTURING

- Panelist 1 **Laurent Bidault** / *STMicroelectronics, Crolles (France)*
Data Scientist for Manufacturing Data Analytics program, with focus on image processing and classification with Convolutional Neural Networks

- Panelist 2 **Bappaditya Dey** / *IMEC, Leuven (Belgium)*
PhD Student from University of Louisiana at Lafayette, USA

- Panelist 3 **Thiago Figueiro** / *ASELTA Nanographics, Grenoble (France)*
VP of Sales, Marketing and Business Development

- Panelist 4 **Ulrich Hofmann** / *GenISys, Taufkirchen, Munich (Germany)*
Founder & General Manager

- Panelist 5 **Philippe Leray** / *IMEC, Leuven (Belgium)*
Director of the Advanced Patterning Department

12:30 - 14:00 Lunch Break is sponsored by **APPLIED MATERIALS**

14:00 - 15:30

Session 10: EUV Mask Inspection & Laser Mask Writers / PMJ2022 Best Paper

Chair: Jan Hendrik Peters / *BMBG (Germany)*
Co-Chair: Thomas Scheruebl / *Carl Zeiss SMT (Israel)*

INVITED

- 14:00 - 14:25 **Importance of Actinic Pattern Mask Inspection in Times of EUVL Execution**
Anna Tchikoulaeva et al. / Lasertec Corporation – European Branch, Dresden (Germany)

14:25 - 14:45 **High-precision optical constant characterization of materials in the EUV spectral range: From large research facilities to laboratory-based instruments**

Victor Soltwisch et al. / Physikalisch-Technische Bundesanstalt, Berlin & RWTH Aachen, (Germany), and IMEC, Leuven (Belgium)

14:45 - 15:05 **Laser Mask Writer addressable to 90nm nodes with a Sustainability profile**

Robert Eklund et al. / Mycronic, Täby (Sweden)

INVITED

15:05 - 15:30 **Best Paper of Photomask Japan (PMJ) 2022 High-precision EUV mask process development**

Shingo Yoshikawa, Tsukasa Abe, Yukihiro Fujimura, Masataka Yamaji, Yasutaka Morikawa, Hidemichi Imai, Hiroyuki Miyashita, Tatsuya Tomita / Dai Nippon Printing, Saitama (Japan)

Presenter: Shingo Yoshikawa

15:30 - 16:00 Coffee Break is sponsored by **PHOTRONICS and EQUIcon**

16:00 - 17:35

Session 11: Lithography Simulation and Future Nano-Lithography & Nano-Patterning

Chair: Andreas Erdmann / Fraunhofer IISB (Germany)

Co-Chair: Kurt Ronse / IMEC (Belgium)

INVITED

16:00 - 16:25 **Curvilinear Mask Process Correction - status quo and outlook**

Ingo Bork et al. / Siemens Digital Industries Software, Fremont (USA)

16:25 - 16:50 **Bio-inspired directed self assembly as patterning solution : when Top-down meets Bottom-up**

Raluca Tiron / CEA-Leti, Grenoble (France)

16:50 - 17:10 **OPC flow for non-conventional designs: specific application to optical diffusers**

Elodie Sungauer et al. / STMicroelectronics, Crolles (France)

INVITED

- 17:10 - 17:35 **SPIE Photomask Technology (‘BACUS’) 2021 Best Paper**
Characterization of mask CD mean-to-target for hotspot patterns by using SEM image contours
*Kan Zhou, Xin Guo, Yinsheng Yu, Hongwen Zhao, Wenzhan Zhou, Yu Zhang, Shanghai Huali Integrated Circuit Corporation, Shanghai (China); Ao Chen, Wenming Wu, Qijian Wan, Huaiyang Dou, Chunshan Du, Siemens EDA, Shanghai (China); Liguozhang, and Germain Fenger, Siemens EDA, Wilsonville (OR, USA);
Presenter: Stewart Wu, Siemens EDA, Heverlee (Belgium)*
- 17:35 - 18:00 **Announcement of ZEISS Award for Talents in Photomask Industry – 1st Place at EMLC 2022**
by ZEISS Semiconductor Mask Solutions (SMS)
- Announcement of SPIE PUV 2022: Photomask Technology (‘BACUS’) + EUVL Conference 2022**
by Emily Gallagher / IMEC, President of BACUS
- Announcement of Photomask Japan (PMJ) 2023**
by PMJ Program Committee Member
- Thanks to Presenters & Participants and Announcement of EMLC 2023, Dresden, Germany**
by Uwe Behringer / UBC Microelectronics (Germany)

17:45 - 18:30

Belgian Beer Farewell*is sponsored by **ASML***

The Belgian Beer Farewell takes place in the Jubilee Hall of KU Leuven.

End of EMLC 2022 conference

**After EMLC 2022:
Visit at IMEC***(optional: max 50 participants)**Kurt Ronse / Advanced Patterning Program Director at IMEC***Schedule:**

- 09:40 Participants should meet at the KU Leuven Faculty Club (FC), i.e. the place of the conference dinner
- 09:45 Departure by coach from FC to IMEC
- 10:00 - 10:45 Welcome + general imec presentation
- 10:45 - 11:00 Presentation on Litho by Kurt Ronse
- 11:00 - 11:15 IMEC video
- 11:15 - 12:00 Cleanroom visit – max 50 people (in groups of 25 people)
- 12:00 Sandwich lunch, *sponsored by* **IMEC**
- 13:00 Departure coach to Faculty Club (FC)
-

Conference Information

Conference Hours

Monday, June 20 th , 2022	02:00 pm to 06:45 pm
Tuesday, June 21 st , 2022	09:00 am to 07:15 pm
Wednesday, June 22 nd , 2022	09:00 am to 06:00 pm

Registration Hours

Monday, June 20 th , 2022	01:00 pm to 06:00 pm
Tuesday, June 21 st , 2022	08:00 am to 05:00 pm
Wednesday, June 22 nd , 2022	08:00 am to 06:00 pm

Technical Exhibition

Parallel to the conference presentations we offer you to take part in the technical exhibition on

Tuesday, June 21st, from 10:00 am to 6:00 pm and
Wednesday, June 22nd, from 10:00 AM to 4:00 pm.

If you intend to participate in the technical exhibition as an exhibitor, please contact

UBC Microelectronics
Dr. Uwe Behringer
Auf den Beeten 5,
72119 Ammerbuch, Germany

Phone: +49 171-455-3196

Fax: +49 7073-50216

e-Mail: uwe.behringer.ubc@t-online.de

Best Paper Award

All conference attendees will elect the Best Paper of the EMLC 2022.

The Best Paper will be invited to present at at PMJ 2023 in Yokohama, Japan.

Zeiss Award for talents in Photomask Industry

VDE is happy to announce that the industry supports student participation by presenting student best paper awards sponsored by Carl Zeiss SMT GmbH.

Winners will be awarded a ZEISS certificate and a trophy. In addition, the winner will be invited to present his/her work at SPIE Photomask Technology Conference in Monterey/CA. He or she receives a donation of 2500 EUR to cover the travel expenses.

General Information

EMLC 2022 Office

For detailed information please contact:

VDE/VDI-Society Microelectronics Microsystems and
Precision Engineering (GMM)

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Phone: +49 69-6308-227

Fax: +49 69-6308-9828

e-Mail: gmm@vde.com

During the conference:

Phone: +49 171 4695 118

Conference Fees

(prices are subject to
21% Belgian VAT)

	until May 20 th , 2022	after May 20 th , 2022
Regular	€ 630.00	€ 730.00
VDE, VDI Members*	€ 600.00	€ 700.00
Lecturer, Program Committee Members	€ 490.00	€ 570.00
Students**	€ 150.00	€ 200.00
imec-tour on June 23	€ 30.00	€ 30.00

* Participants claiming for the membership fee must verify their membership.

** A copy of the student card must be attached.

Conference Participation includes

- Coffee / tea and beverages of the conference breaks at the Jubilee Hall of KU Leuven on Monday, June 20th afternoon, Tuesday, June 21st morning and afternoon, and Wednesday, June 22nd morning and afternoon.
- Participation at EMLC 2022 Get Together on Monday, June 20th early evening at the Jubilee Hall of KU Leuven.
- Lunch sandwiches and beverages at the Jubilee Hall of KU Leuven on Tuesday, June 21st, and Wednesday, June 22nd.
- EMLC 2022 Dinner at Facility Club of KU Leuven on Tuesday evening, June 21st.
- Free Access to the EMLC 2022 Technical Exhibition at the Jubilee Hall of KU Leuven.
- Participation at “Belgian Beer Farewell” at the end of the conference on Wednesday, June 22nd at the Jubilee Hall of KU Leuven.

Payment of Conference Fee

Payment for registration, including bank charges and processing fees, must be made in Euro. The conference fee has to be fully paid in advance by credit card. Your registration can only be confirmed if VDE-Conference Services has recorded receipt of your full payment.

Cancellation

In case of cancellation, provided that VDE-Conference Services has received written notice until 30 days before the event, the registration fee will be fully refunded less a handling fee of 80,-EUR. In case of cancellation after this date, no refund will be made.

Conference Venue

Katholieke Universiteit Leuven
University of Leuven, University Halls
Naamsestraat 22
3000 Leuven, Belgium

The EMLC 2022 Program Committee of the 37th European Mask and Lithography Conference, EMLC 2022, would like to express their sincere appreciation to all the sponsors and cooperating partners mentioned below for their support

Sponsors



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Cooperating Partners



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Courtesy of Toppan Photomasks