MICRO-OPTICS IS...

Phabulous

# Annual Report 2021

www.phabulous.eu

MICRO-OPTICS IS...


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# Foreword President

## The rise of the association

Micro-optics was a field for specialist since its starting almost 25 years ago. A steady but moderate growth lead to many products in different applications. But in recent years, one can feel the excitement of the community to reach a new level: Micro-optics can be found in mass products for customer and automotive industry. Some call it the micro optics revolution, others are just happy that now optical devices can be designed using increased performances and very small footprint.

All this became possible by the introduction of new and combination of established fabrication technologies like precision roll-to-roll replication, roll-to-plate fabrication or imprinting on wafers. To not loose dynamics of the trend, the PHABULOµS project was established and with it the PHABULOuS Pilot line Association which was registered at the chamber of commerce at its homebase in Neuchatel, Switzerland in October 2020 to create an operational platform to develop a complete micro-optics technology chain.

In 2021, by signing of all the legal contracts and the hiring of Jessica van Heck as first official employee, the association became operational. A preliminary business plan was created, showing the roadmap to make the vision of PHABULOuS a reality. It is the place to be for the community for micro-optics. It is open to every person and/or company active in the field of micro-optics. Whether at is as a supplier of products or services or companies looking to implement micro-optical components into their systems.

The potential for  success is there. Seeing the number of patent request and papers around free-form micro-optics growing exponentially I am sure that the success will not be delayed. As a single-entry-point that combines the strengths of all the members representing a full supply chain, we have in our association surely a unique selling point that can open up markets.

To accelerate the potential, there is also funding available for companies to start implementing free- form micro-optical components. An open call that will benefit the entire community of the first class partners within the association as well as the users. I am confident that we can all grow and bring each other on the top of competition

So as a final word, let us all promote this unique cooperation and the great opportunities it offers. Let's make it a #phabulous year for our association.

**Toralf Scharf**
President PHABULOuS Pilot Line Association

# The Association

**The PHABULOuS Pilot Line Association was established as a single point of entry to customers for the exploitation of the services of the Pilot Line members. The Association is an independent legal entity with legal capacity governed by the bylaws signed by its thirteen Founding Members.**

## Objectives

The PHABULOuS Pilot Line Association is established within the framework of the H2020 European research project entitled "Pilot-Line Providing Highly Advanced & Robust Manufacturing Technology for Optical Free-Form Micro-Structures" funded by the European Commission ("PHABULOµS Project").

The main objectives of the PHABULOuS Pilot Line Association are to:

- Implement the PHABULOµS Project in accordance with the Grant Agreement n°871710.
- Unify European research and technology organisations and industrial partners into a Pilot Line for the design and manufacturing of free-form micro-optics solutions.
- Test the efficiency of the pilot line concept through the validation of requests for piloting services within the implementation of the PHABULOµS Project.
- Promote advanced micro-optics technologies and solutions and offer a single-entry point (one-stop shop) in order to facilitate access to comprehensive problem-solving competency for the complete production chain.
- Represent the interests of the micro-optics community on a national and international basis.

## Board of Directors

The PHABULOuS Pilot Line Association is owned by its members and managed by its board of directors:

- Toralf Scharf (President), Director Technology at SUSS MicroOptics (Switzerland)
- Paul Hartmann (Vice-President), Director of Institute MATERIALS at Joanneum Research (Austria)
- Philippe Steiert, Director of CSEM Regional Centers at CSEM (Switzerland)
- Onno Lint, CEO and Co-Founder at Morphotonics (Netherlands)
- Veli-Pekka Leppänen, CEO and Co-Founder at Nanocomp (Finland)
- Richard Clark, Finance Director at PowerPhotonic (United Kingdom)






# Pilot Line Front Office

The daily operations of the PHABULOuS Pilot Line Association are run by the Pilot Line Front Office (PLFO):

- Jessica van Heck, Managing Director
- Ton Offermans, Technical Coordinator


# Members

The PHABULOuS Pilot Line Association has 13 members from 10 countries:

- CSEM (Switzerland)
- Joanneum Research (Austria)
- Fraunhofer FEP (Germany)
- CEA-Leti (France)
- SUSS MicroOptics (Switzerland)
- Morphotonics (Netherlands)
- Nanocomp (Finland)
- Wielandt UPMT (Belgium)
- LASEA (Belgium)
- PowerPhotonic (United Kingdom)
- Limbak (Spain)
- EPIC (France)
- AMIRES (Czech Republic)

# Markets & Customers

**The services of the PHABULOuS Pilot Line Association are available for all markets. Based on some initial market analysis, the main target markets have been defined. For these markets, special business development team has been assigned to attract customers to the pilot line services. The customer base consists of use cases (consortium members of the project), pilot cases (companies that benefit from the available funding) and customers (any other company that is interest in using the pilot line services.**

## Target Markets

The following markets have been defined:

- AR/VR
- Automotive
- Consumer electronics
- Decoration & Luxury
- Healthcare & Life sciences
- Imagers & Displays
- Lighting
- Optical communication
- Security & Branding
- Solar, Energy & Daylight
- Transportation

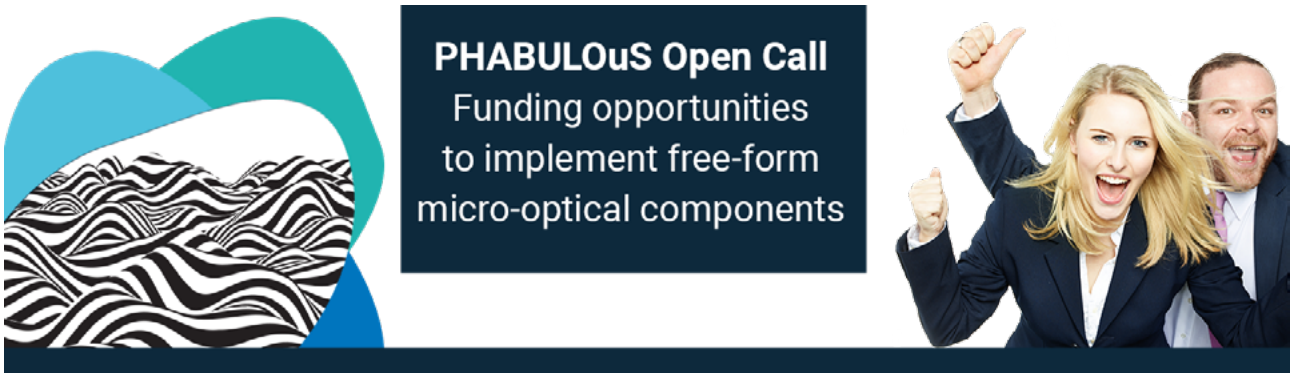
The first year (2021) was all about setting up the right procedures. Fortunately, the interest in the pilot line and its services resulted already in 54 leads from 18 countries logged in the CRM system that became fully operational in December 2021.

# Validation through use cases

The use cases are the first customers of the PHABULOuS Pilot Line services through the PHABULOµS Project. The technical coordination of the use cases started with the project in January 2020 and have been taken over by Ton Offermans per 1 September 2021.

There are six companies part of the PHABULOµS Project to serve as first "customers" of the pilot line services:

- Limbak, use case for AR/VR (Spain)
- Microoled, use case for micro-displays (France)
- Seisenbacher, use case for transportation lighting (Austria)
- Swarovski, use case for decoration and luxury (Austria)
- HELLA, use case for automotive headlights (Germany)
- Zumtobel, use case for solid state lighting (Austria)




# Support for pilot cases

The pilot cases are the customers that will receive support through the PHABULOµS Project. There is €3M of funding available for the PHABULOuS members to execute services to support European companies looking to implement free-form micro-optical components into their systems. In 2021, preparation have been made by the PHABULOuS Pilot Line Association to prepare for the launch of the open call (January 2022).

Up the 3M€ of funding is available to support a minimum of 20 pilot cases / early adopters. They will be selected within the project to implement free-form micro-optical component and integrate that into their product developments with the aim to go towards large-scale production. The exact amount of subsidies per applicant will be decided based upon the type of company (see who) and the three main selection criteria (see process). For each pilot case, also an in-kind contribution from applicant is expected.

The Call will be open from January 2022 to November 2023, and applicants will be able to apply anytime. Any submitted proposal will be evaluated in the nearest cut-off (deadline: 17:00 CET). Cut-off dates are:

- 31 March 2022
- 30 June 20222
- 30 November 2022
- 31 March 2023
- 30 June 2023
- 30 November 2023

**More information on the open call can be found on www.phabulous.eu/open-call**

# Technology & Services

**PHABULOuS represents the full value chain and consists of Europe's leading companies and research and technology organisations in the field of micro-optics. As pilot line, we offer a full range of services from optical design and origination to pilot and volume production, including tooling, material selection and quality control. All synchronised to ensure a smooth and professional process to reduce lead times from several months to several weeks. To achieve this, several improvements have been made during 2021 as part of the acceleration phase.**

## Analysing manufacturability

In order to improve the capability of the Pilot Line to serve customers various processes, several tools have been developed to facilitate the analysis of new designs for their manufacturability:

- Automatically identify parts of the design (height, curvature, slopes) that exceed manufacturing constraints
- Identify the minimal feature size in the design, facilitating the selection of the right origination method
- Smoothen sharp edges in the design to accommodate origination and replication constraints,
- Convert CAD designs into a ray traceable solid (using NURBS) and vice versa.

## Improving origination processes

The initial status of the origination technologies was confronted with the demands of the use-cases and the main bottlenecks were identified: surface quality, origination speed, and lead time. These bottlenecks were successfully addressed:

- Laser smoothening processes were developed to reduce surface roughness inherent to laser ablation.
- Writing times by Single and Two Photon Absorption could be reduced significantly by using a grey-scale writing approach.
- Lead times were analysed and the steps contributing to the overall lead times identified. Using the design tools data exchange and customer design refinement could be reduced substantially. The time needed for inspection and quality control was reduced by speeding-up characterization both in surface metrology itself and the internal workflows or characterizing masters and replicas based on the experience of a round robin.

## Upscaling to larger areas

Upscaling by Step & Repeat UV imprinting has been successfully applied in several use cases to upscale microlens and microprism arrays to larger areas (up to 0.17 m2) , demonstrating seamless stitching with a nearly invisible stitch line. A complementary process was developed for upscaling large area flexible stamps to even larger area (2-up and 4-up tiling to >1.5m$^2$) for Roll-2-Plate replication. Large area electroformed Nickel tools as well as metallized flexible masters were demonstrated for direct uses as Roll-to-roll reel.

## Developing new materials

In addition to existing UV imprinting materials, several new material formulations have been developed for the use cases needing tailored material properties. Conformal metallic coating on micro-structured surfaces was demonstrated with high optical (reflectance) and mechanical (adhesion) quality.

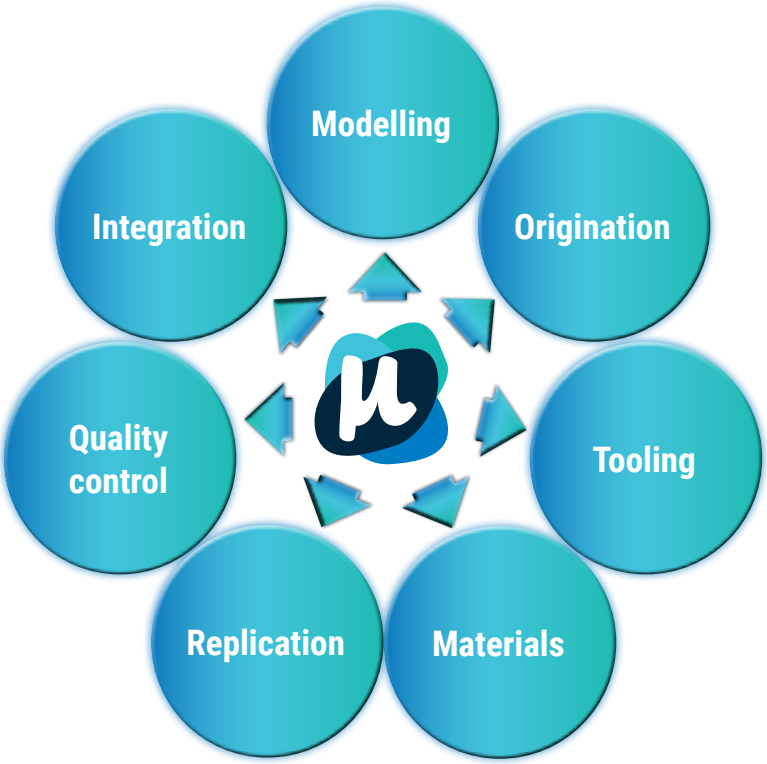
## Implementing inspection methods

Various inspection methods were investigated and those most suitable for the replication lines were implemented, using machine vision system to determine defect density as well as AI algorithms that detect cosmetic imperfections.

## Documenting capabilities

The most important parameters and technological limitations related to different origination, up-scaling, tooling and cutting technologies available for PHABULOuS Pilot Line, have been collected, quantified, and documented in a database. The database can be used as a guideline when feasibility and profitability of a new business case is to be evaluated.

The characterization portfolio of PHABULOuS has been collected and summarized in a table form including technical information of available equipment, contact details and cost breakdown, limitations, alternatives, practical advises and instructions.



# Ecosystem

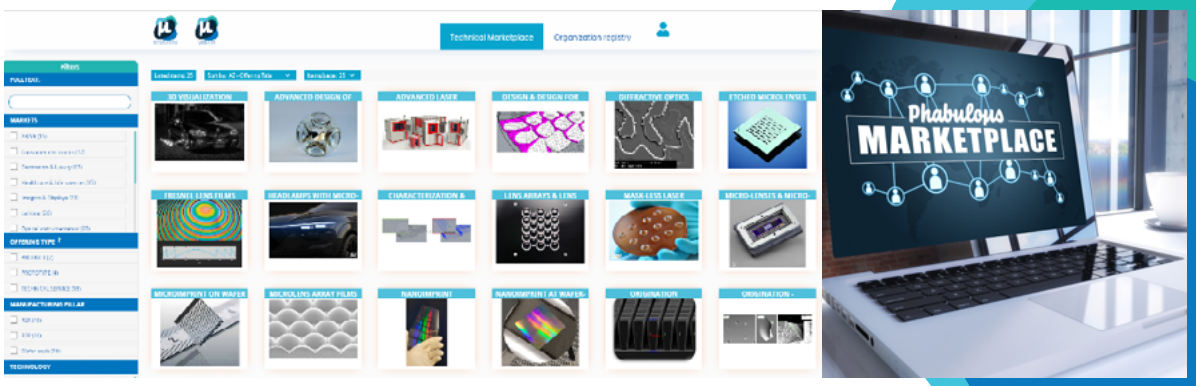
**One of the aims of the PHABULOuS Pilot Line Association is to represent the interests of the micro-optics community on a national and international basis. For this a Community Management Platform is created. This digital platform showcases a comprehensive catalogue of organizations, products and services and other relevant information for the micro-optics community.**

## Launch Organization Registry & Technical Marketplace

The PHABULOuS Ecosystem is available at ecosystem.phabulous.eu and consists of three modules:

- Organisation registry - overview of organisations active in micro-optics
- Technical marketplace - overview of products and services by companies active in micro-optics
- Community - overview of relevant information for anyone interested in micro-optics (from February 2022)


The first two modules of the Community Management Platform went live end of November 2021.
The organization registry is a representation of the companies active in the value chain for micro-optics.
The technical marketplace gives an overview of the capabilities and offerings of the various companies.
It was launched with the member offerings, but it open to any company active in the field of micro-optics.



# Collaborations

PHABULOuS works together with other pilot lines, projects and EU initiatives in Europe and organises specific activities together:

- JePPIX Pilot Line: shared booth, webinar and video
- MedPhab Pilot Line: shared booth, webinar and video
- PHENOmenon: shared workshop
- PhotonHub: partner / active participation
- PIXAPP Pilot Line: shared booth and webinar

# Memberships

PHABULOuS has joined several European networks to further build up the ecosystem and is member of:

- EPIC
- Photonics Austria
- Swissphotonics

# Social Media

PHABULOuS utilises Social media reach its community and gain visibility.
Social Media is used to announce events, share partner news, give updates on the progress in the project and more.
Here some statistics of our social media profiles for 2021.

LinkedIn:

- 61 posts (+20)
- 462 followers (+245)
- 30332 impressions (+8472)

Twitter:

- 47 tweets (+17)
- 178 followers (+87)
- 19287 impressions (-15757)

YouTube:

- 12 videos (+9)
- 25 subscribers (+18)
- 612 views (+136)




# Publications

**To support the objective to promote advanced micro-optics technologies and solutions and offer a single-entry point (one-stop shop), PHABULOus publishes several articles, interviews, press releases, documentation and videos, in order to facilitate access to comprehensive problem-solving competency for the complete production chain.**

## Press & Media

PHABULOuS is mentioned in various articles and papers. PHABULOuS also gives interviews and releases press releases. Here an overview of where PHABULOuS was seen in press and media:

- Article: European manufacturing capabilities for photonics
- Article: Nanophotonics Are at the Heart of Advancements in Quantum Computing, 5G, and More
- Article: Exploring Emerging Applications for Photonic Integrated Circuits
- Interview: Forschungsprojekt PHABULOuS: Aufbau von Kompetenzen und einer Anlaufstelle
- Paper: CAD-based metrology of freeform microlens arrays, FMLAs in SPIE Digital Library
- Press Release: establishment of the Association
- Press release: Hiring the new Head of Business & Sales




# Videos

PHABULOuS released several videos on its YouTube channel of presentations given. At the end of 2021, it also released its official promotional videos making an introduction to the pilot line and its services. Videos can be viewed on online on the “PHABULOuS EU” YouTube channel.


# Documentation

PHABULOuS publishes documention relevant for the community. In 2021, six use case flyers were placed on the website to inform the community about the objectives of the use cases for different markets:

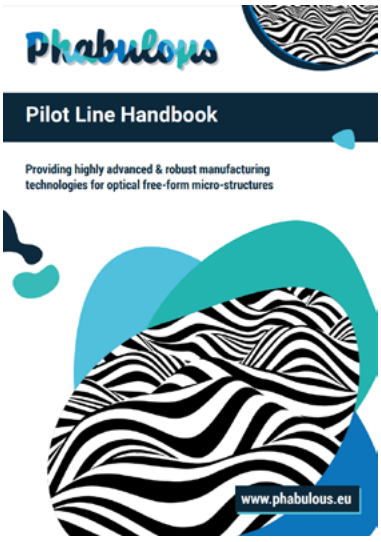
- Automotive & functional lighting
- Luxury
- Micro-displays
- Solid-state lighting
- Transportation interioir lighting
- Virtual & Augmented reality







PHABULOuS continuously updates a technology handbook, showing the comprehensive offer of its members. In 2021, the third version of this handbook was published. The handbook is available on www.phabulous.eu under the section downloads.



# Events

**PHABULOuS is visible at many events, both through the efforts of dissemination and communication partner EPIC as well as through the efforts of other members. In 2021, PHABULOuS was visible at xxx**

## Online Technology Meetings

- 3D Printed Optics: State of the Art and Applications
- Advanced Photonics in Urology
- Challenges for LED/MiniLED/MicroLED
- Head-Up Displays: from 2D to AR
- Human-centric Lighting and Applications
- Impact of Photonics on Sustainable Textiles, Wearables, Fashion and Design
- Increasingly Important Role for Mid-Infrared Photonics
- Laser Micromachining
- LIDAR 2.1 Applications for 2021
- Low Light Cameras Technology and Applications
- Medical Devices
- Medical Devices for Surgical Procedures
- Mid-IR Technologies for Environmental Monitoring
- Mid-IR Technologies for Security & Surveillance
- Moulded Optics
- New Opportunities Now for the Quantum Photonics Supply Chain
- Next Steps Fast Growing Freeform Optics Applications
- Next Steps for Smart Glass in AR and Related Applications
- Novel Photonic Solutions for Microscopy
- Photonics Impact on Green Energy Generation: Photovoltaics, Wind, Hydrogen, Wave
- Roadmap 2021 for Co-packaged Optics
- Special Focus on CMOS Imagers Applications
- Special Focus on Photonics for Robotics
- Spectroscopy and Imaging for Process Monitoring
- The Role of Photonic Sensors and Lighting in Advanced Agriphotonics




# Exhibitions & Conferences

- ANGELTECH PIC Pilot Line Conference
- ANGELTECH VIRTUAL LIVE III
- LOPEC Trade fair and conference for printed electronics
- NNT – International Conference on Nanoimprint and Nanoprint Technologies
- OFC Exhibition
- PHOTONICS+ Virtual Exhibition and Conference
- PIC International Conference
- SPIE Photonics West
- W3+ Fair Convention



# Other events

- Automotive and Photonics Online Symposium
- Industry Insights: The future of cell phone camera lens manufacturing
- Internal Investors Workshop
- IVAM Hightech Summit
- Nano & Industrie 2021: Anwendungen in der Photonik
- NIL Industrial Day
- OSA Freeform and Optical Fabrication & Testing meeting
- R&D Innovation, Digitalisation & Sustainability Online Summit
- SPIE Optical Systems Design
- Techblick Online Conference on Emerging Technologies
- VTT Vorarlberg technology day
- Webinar “European photonics manufacturing services funded by EC“
- Webinar Virtual Reality Optics: Present and Future
- Workshop: Advances in design, fabrication and applications of free-form micro-optics



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## CONTACT

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The PHABULOuS Pilot Line Association was founded as part of the PHABULOµS project through funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 871710 as an EC funded initiative, in a public-private partnership with Photonics21. www.photonics21.org

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