Flexible Optical Injection Moulding of optoelectronic devices

Grant agreement nº: 820661

Call identifier: H2020-NMBP-FOF-2018

Deliverable D8.9b

Communication Kit

Work Package 8

Dissemination, Exploitation and Communication

Document type	:	Report
Version	:	V2
Date of issue	:	30th November 2020
Dissemination level	:	Confidential
Lead beneficiary	:	AIMEN

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 820661.

Executive Summary

This report is an update of deliverable D8.9, version a. The report aims to gather all the new information generated within the last 18 months, related to the FLOIM project including narrative text, photographs, slides and any other suitable communication material. This text targets a general audience, in order to show clearly the benefits the project can bring to society. This document will be updated during the project life.

The deliverable is divided into two parts. The first one includes the information of the first version of the deliverable (D8.9a) and the second part includes all the material generated from February 2019 to December 2020.

Contribution and revision history

Version	Author(s)	Changes	Date
V1	AIMEN	First version of the Deliverable D8.9a ready for submission	28th February 2019
V2	AIMEN	Second version of the deliverable (D8.9a + D8.9b)	24th November 2020

This deliverable has been evaluated by the members of the Quality Control Group (QCG), following the procedure indicated in deliverable D9.1: Quality Assurance Plan.

Quality Control Group Member	Partner
Pablo Romero	AIMEN
Christian Rankl	RECENDT
Jan Edelmann	Fraunhofer
Mikel Gomez	CEIT

The final version of the document, has been reviewed and approved for submission by the Project Coordinator.

Table of Contents

1. PART 1 – DELIVERABLE D8.9A

1.1. NARRATIVE TEXT FOR FLOIM DISSEMINATION

Miniaturized, integrated photonic devices are driving an increasing number of applications, while facing pressure to lower cost and increase flexibility.

Improving the cost efficiency, flexibility and environmental footprint of the complete integrated optoelectronics workflow, can provide European industry with a key tool for excelling in advanced applications and differentiating their products, while keeping production, innovation capacity and key Intellectual Property in Europe, which is the main goal of the FLOIM project.

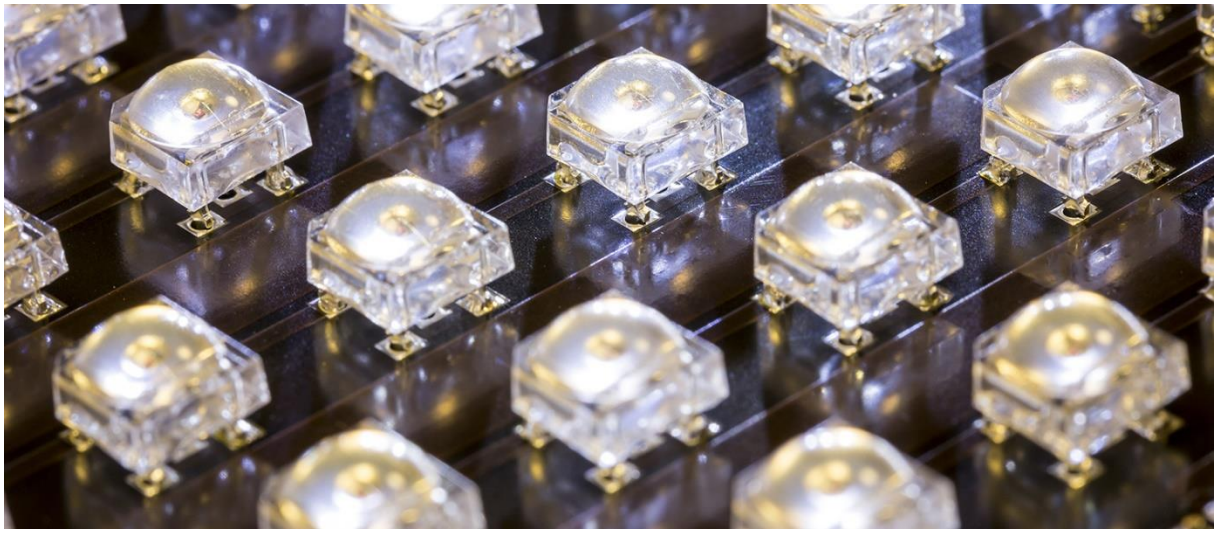

Figure 1. LED array with injection moulding embossing.

The central concept on which the project rests is the overinjection of optical quality thermoplastic polymers directly on the active optoelectronic component, into a proper cavity that incorporates the geometrical micro and nanofeatures, which provide the polymer surface with the required optical functions.

This concept is grounded in the well-proven technology of Injection Moulding (IM) for high quality plastic optics (and variants like Injection Compression Moulding, ICM), extending the capabilities of the technique to enable a single step optical embedding. This single step process will substitute a number of operations usually required in production of optoelectronics, including microoptics production, handling, optomechanics attachment, positioning, alignment and encapsulation.

As an advanced development, the project will explore the generation of complex optical functions through replication of nanostructured mould surfaces, which can produce controlled diffractive effects -from lensing to wavelength splitting- extending the design space for extraordinary innovation potential and miniaturization. This will also reduce the number of assembled components, as discrete optics like diffusers or gratings could be directly moulded into the part.

The single step optical embedding will be enabled by a series of advances, result of the research activities during the project, which are supported by the solid competences of the consortium partners

in their respective fields: tooling technology, injection moulding process development, optical design, sensing, inspection and advanced control.

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1.3. FLOIM PROJECT FLYER

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FLOIM
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The production chain for optoelectronic device manufacturing is inherited from microelectronics, which is not appropriate for novel, low cost, high efficiency photonic devices.

Project Duration:
42 months

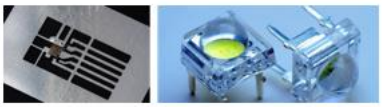
Starting project date:
1st of September, 2018
http://www.floimproject.eu/

OBJECTIVES AND ADVANTAGES

FLOIM will pursue the following technical goals:

- Novel manufacturing chains for high quality integrated optical devices.
- Design new manufacturing equipment for functional optical embedding.
- Custom optical functions through mould insert machining and structuring.
- Sustainable production of eco-friendly optoelectronics.
- Disruptive applications

Miniaturized, integrated photonic devices are driving an increasing number of applications, while facing pressure to lower cost and increase flexibility.



Improving the cost efficiency, flexibility and environmental footprint of the complete integrated optoelectronics workflow, can provide European industry with a key tool for excelling in advanced applications and differentiating their products, while keeping production, innovation capacity and key Intellectual Property in Europe.

MAIN INNOVATIONS

The innovations to be generated during the project have been identified and categorized into two categories:

1. Product and Process design principles:
   - Optics design for highly integrated optical integration and embedding.
   - High quality optical injection moulding.
2. Manufacturing Platform:
   - Integrated optical embedding technology, for High-precision injection moulding using modular and reconfigurable mould with quick insert exchange, and optical function reconfiguration by selective restructuring of diffractive insert nanostructures.
   - In line quality assessment, full quality evaluation and zero defect goal.
   - Compatible continuous part handling, control software system and mechatronic peripherals.

2. PART 2 – DELIVERABLE D8.9B

2.1. UPDATE OF THE NARRATIVE TEXT FOR FLOIM DISSEMINATION

A new narrative text has been written for all partners to do local press releases. The content this press release should include is cited as follows and has already been used by AIMEN and other partners:

FLOIM, improving mobile and another electronic device technology

New automatized manufacturing technology enabling optical assembly of optoelectronics in many solutions (light management, lighting, display, sensing, high quality holography and imaging, etc.)

Improving the cost efficiency, flexibility and environmental footprint of the complete integrated optoelectronics workflow, can provide European industry with a key tool for excelling in advanced applications and differentiating their products, while keeping production, innovation capacity and key IP in Europe.

In this context, FLOIM will develop an automated process for optical assembly of optoelectronic devices, based on optical quality injection overmoulding. Freeform and microstructured optical surfaces are generated directly on the components through thermoplastic microreplication, using microstructured inserts. The technology aims to simplify the assembly routes for heterogeneously integrated optoelectronics, with drastic cost reduction, high productivity and improved device performance.

Contribution to European photonics industry

The manufacturing solution developed in FLOIM will contribute to improve competitiveness of European photonics industry at large, generating growth and jobs, creating new market opportunities for optoelectronic device manufacturers and enabling the manufacturing of innovative products for many solutions (light management, lighting, display, sensing, high quality holography and imaging, etc.).

FLOIM has the potential for a relevant impact in photonics and optoelectronics industry and its applications at large. Estimations based on current markets status leads to a potential impact of FLOIM, when adopted by manufacturing industry, generating up to 5,200 jobs and an additional market share of €1,195M for EU companies in the sectors tackled by the project.

FLOIM in citizens daily life

FLOIM will enable highly advanced innovations for European key sectors like manufacturing, communication and information, healthcare, transport, energy… radically improving and creating new functionalities to respond to their market's needs. FLOIM will also contribute to enhance people's life quality boosting digital connectivity and enabling efficient and comfortable mobility. Indeed, within the project, the technology will demonstrate its viability to deliver the following new or improved products and services:

European consortium

FLOIM consortium is composed by 12 entities from seven EU countries. Namely, it counts with five research centres: AIMEN Technology Centre (Spain), CEIT-IK4 (Spain), FRAUNHOFER-IWU (Germany), RECENDT - Research Center for Non Destructive Testing (Austria) and UPC - Universitat Politècnica de Catalunya (Spain); as well as with four technology suppliers: ADAMA INNOVATIONS (Ireland), MASSO - MONDRAGON ASSEMBLY (France), PROMOLDING (Netherlands) and SNELLOPTICS (Spain). Finally, three end-users close the consortium: FAGOR AUTOMATION (Spain), FLEXENABLE (UK) and HYBTRONICS MICROSYSTEMS (Spain).

End-users (FAGOR, FLEXENABLE and HYBTRONICS) define the products that will demonstrate FLOIM technology, while SNELLOPTICS is in charge of the optical design of such products. AIMEN, CEIT, FRAUNHOFER-IWU and ADAMA are working with advanced manufacturing technologies, such as multiphoton polymerization, direct laser machining, high accuracy micromilling and Ion-Implant Lithography, in order to develop tooling able to provide optical functionalities by injection moulding, process handled by PROMOLDING and UPC. ADAMA, FRAUNHOFER-IWU and RECENDT are developing complete control and monitoring systems of the injection moulding process, and MASSO leads the integration of the individual developed modules into a manufacturing pilot line that will serve as a test benchmark for the FLOIM technologies.

(Here each partner should explain their main contribution to the project, or the capabilities they would like to advertise. As an example, the text used by AIMEN is reproduced as follows)

In FLOIM, the role of AIMEN is to act as project coordinator, as well as to provide intensive research support to the development of the core technology of the project, particularly the tasks related with materials and laser processing.
High power ultrafast laser systems available at the AIMEN Laser Applications Centre, together with robust optomechanical workbench and advanced nanopositioning systems, will allow testing the current upper limits of laser beam micro and nano-structuring by multi photon polymerization and direct laser micro machining.
AIMEN will test, produce, characterize and optimize a range of micro and nanostructures able to generate optical functionalities that can be replicated by injection moulding, such as light diffraction or diffusion. This will allow mass production of high quality, complex, embedded optoelectronic components at a much lower cost than current market technologies.

Details

Title: Flexible Optical Injection Moulding of optoelectronic devices
Partners: 12
Countries: 6
EU Funding: 6.7M€
Start Date: 01/09/2018
Project Duration: 42 months
Project Consortium:

For additional information please contact:
Project Coordinator: AIMEN Technology Centre
Contact: Nerea Otero
E-mail: notero@aimen.es

Visit our website http://www.floimproject.eu/
and follow us on Twitter @FloimProject

2.2. NEWLY GENERATED DOCUMENTS

Two new flyers have been generated since Deliverable 8.9a submission, and they are included as an annex of this document.

A 4-point diagram was recently elaborated, with the key benefits of FLOIM project to citizens in their daily life. This one-page diagram can be included in any dissemination documents, as has been done with the press release, to reach out to citizens not familiar with the technologies or with no knowledge of the project.

A poster, summarizing the key technologies present in the FLOIM project, has been generated. This poster can be used in any in-situ scientific FLOIM publication, such as conferences.

2.3. WEBSITE ACTIVITY

FLOIM website was updated through the duration of the reporting period, where several elements were particularly active, such as the Blog and events sections, where short publications on young minds and women involved in FLOIM project were uploaded (Figure 2).

Also, the communication material generated throughout the project duration is being regularly uploaded to the website, for ease of access by any partner, and the events attended by FLOIM members related to the project are being mentioned on the news section (Figure 3).

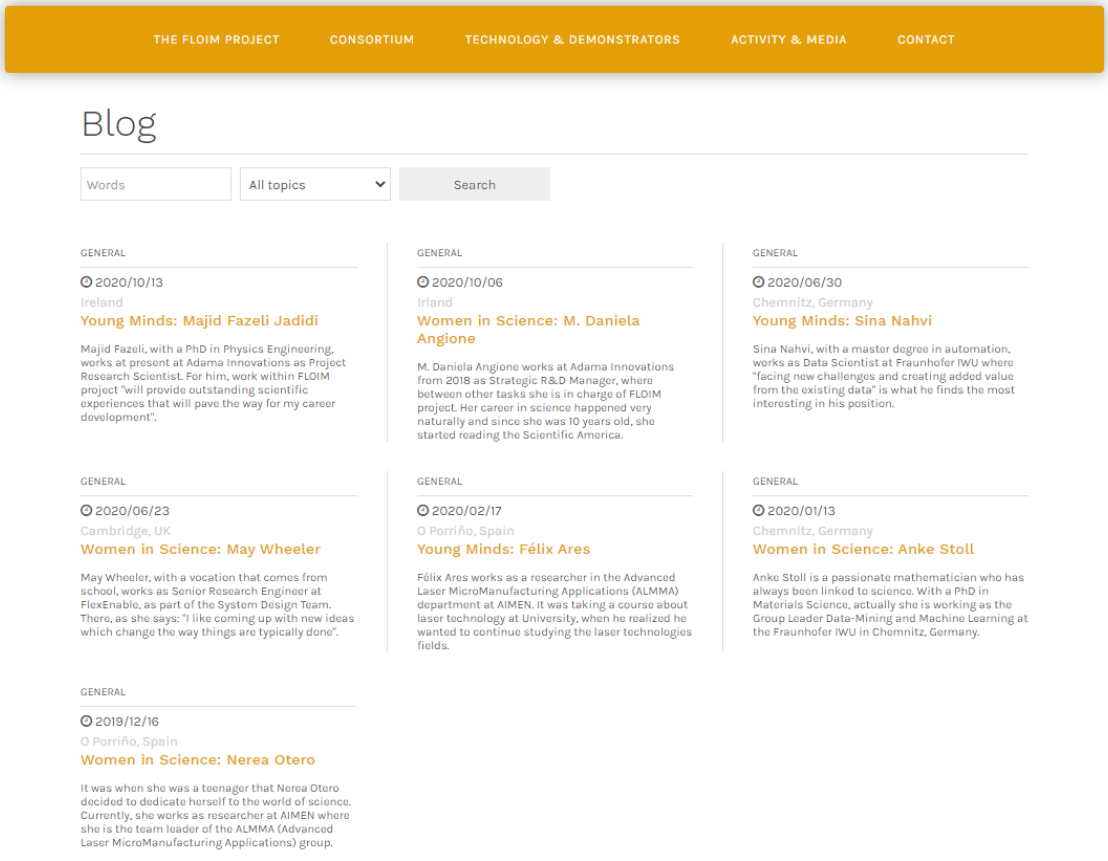


Figure 2. Blog section on FLOIM website

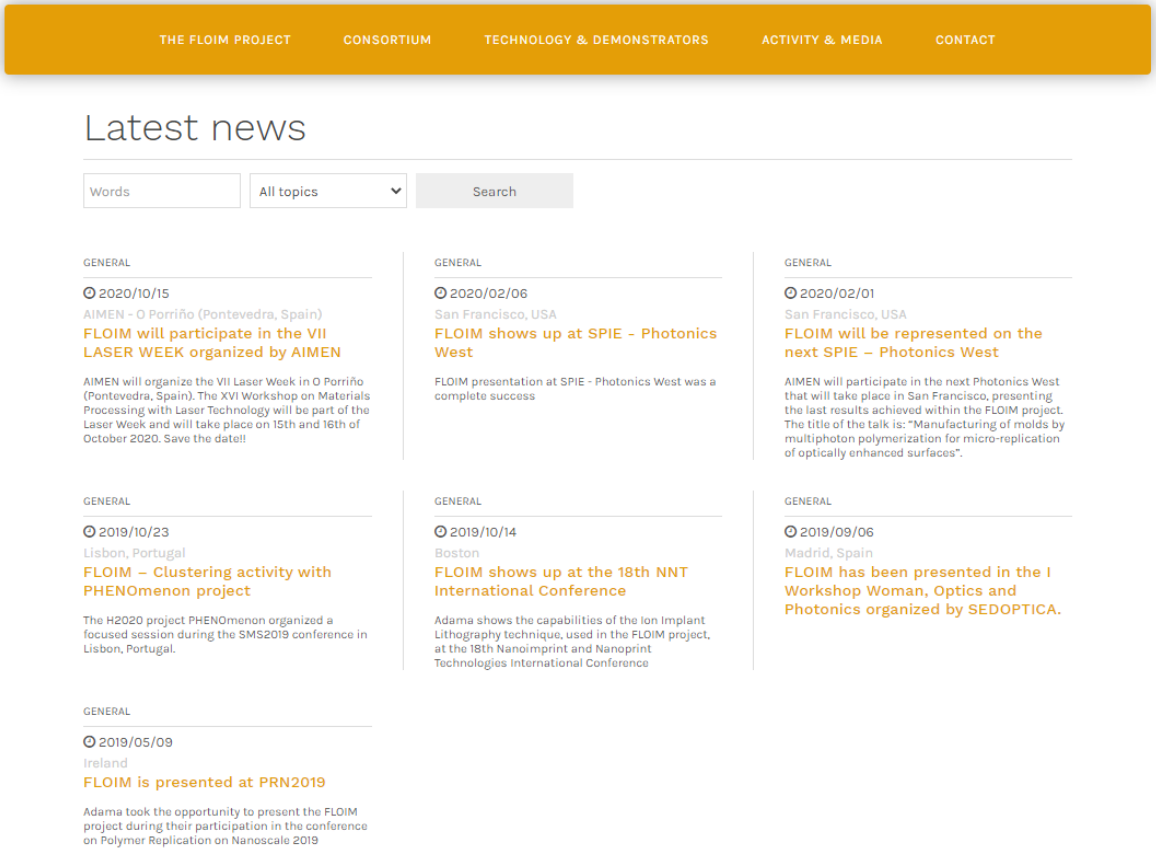


Figure 3. News section on FLOIM website

Overall, the FLOIM website aims to gather all the information related to the project that may be relevant to the public, while social media accounts, as FLOIM Twitter account, are focused on the task of increasing the project's visibility.

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2.5. FLOIM PROJECT NEW DOCUMENTS

1st year flyer

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Partners

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1 Year of FLOIM

FLOIM project started one year ago. During these past 12 months, efforts were focused on 2 different subjects:

- Developing the key technologies that will allow manufacturing moulds with structures in the micro and nanoscale, which will transfer optical functionalities to the injected materials.
- Developing systems to guarantee a robust quality control of the manufactured parts.

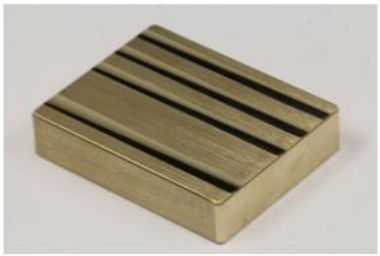
Key manufacturing technologies

Laser technologies are used for the development of the final demonstrators of the FLOIM project. This clean and efficient technology allows for the processing of surfaces avoiding the use of other chemical or physical additives. Laser machining is being studied at CEIT, while two-photon photopolymerization is investigated at AIMEN as means to generate structures on mould inserts.

"Laser micro/nanostructured mould insert processed at Ceit with a high repetition femtosecond laser".

Fhg-IWU has been investigating shape accuracy and surface quality when mechanically structuring the mould inserts with cylindrical lens geometries.

First, potential materials for the moulding of optical components were procured, mould inserts produced, and finally machining tests were carried out.



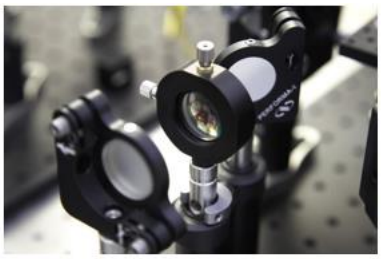
"Brass insert micromachined at Fhg-IWU with a Kugler MM3 micromachining center".

Control systems

In the FLOIM project, RECENDT is responsible for the development of fast, non-destructive testing methods to control the process quality and performance. Two different measurement systems based on OCT (optical coherence tomography) will be engineered:

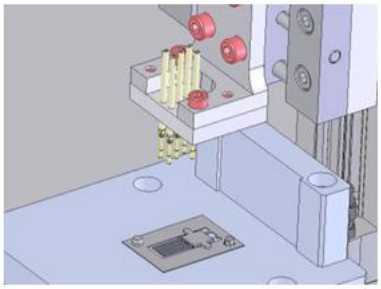
- In-mould OCT for the monitoring of the alignment of the active optical components in the mould.
- Development of an OCT setup combining galvoscanners and positioners for the quality control of manufactured parts directly after the injection moulding process.

In the first year of the project, RECENDT laid the foundations for the systems to be developed, worked on the definition of the system specification and analysed the first available test samples.



"Laboratory setup for OCT measurement at RECENDT ".

For validation of the optical and electrical behavior of the final manufactured parts, Mondragon Assembly has designed a quality control station for a Fibre Optical Transmissor demonstrator. A prototype has been built and its electrical behavior validated.



"Mondragon design of the quality control station for HYBTRONICS FOT demonstrator"

2nd Year Flyer

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Second year of FLOIM

FLOIM project started two years ago and has come a long way since its beginning. In the last 12 months, the consortium has validated the initial proposed manufacturing technologies, and further developed the systems of in-mould and inline quality control.

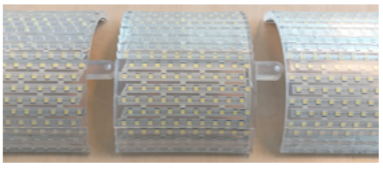
Key manufacturing technologies

AIMEN focused on laser Two-Photon polymerization, to structure a hard resin on top of steel inserts, suitable to be used in injection moulding. Resolution achieved with this technique is within the hundreds of nanometers range, and it has been successfully replicated by injection moulding.

"AIMEN logo replicated by injection moulding from a photopolymerized hard resin insert".

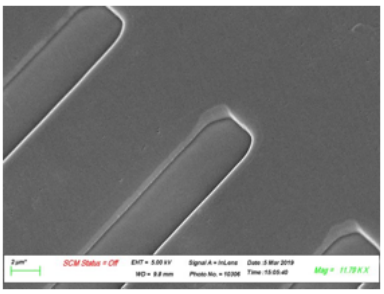
The replicated inserts proved to be resistant to the injection process, being able to withstand tens of replications without showing signs of weathering.

SnellOptics designed a light-directional lens system for overmoulding a curved BLU LED matrix from FlexEnable. This design allows a curved display to direct the light to the user, at 30°. PROMOLDING has tested different materials for its overmoulding, coming up with flexible and rigid curved alternatives.



"FlexEnable LED matrixes, overmoulded by PROMOLDING with a light-directional lens system designed by SnellOptics".

ADAMA innovations has been coating steel inserts with DLC and structuring them by Ion Implant Lithography (IIL), which provides a resolution in the range of tens of nanometers. This will allow manufacturing a very accurate diffraction grating, needed for FAGOR demonstrator, a miniaturized scanning head for optical encoders. The manufactured inserts have been successfully replicated by PROMOLDING with their injection moulding machines.



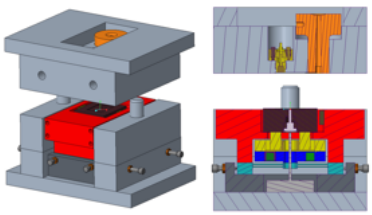
"ADAMA innovations IIL structured grating, replicated by PROMOLDING with their injection moulding machines".

Control systems

FLOIM aims to develop a very thorough and all-around control system, that includes an off-line quality control and in-line, in-mould control system for the manufacturing pilot line that will be assembled to demonstrate the technologies developed during the project.

For the in-mould control, Recendt, Fraunhofer-IWU and ADAMA innovations have been closely working together, to design a system that will include:

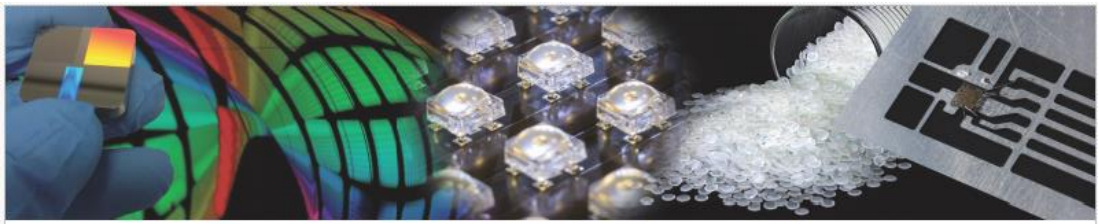
- An OCT system developed by Recendt, that will measure any insertion errors and geometric tolerances of the components to be overmoulded.
- A 3-axis mechatronic device designed and manufactured by Fraunhofer-IWU, that will compensate the measured errors with micrometric accuracy.
- A filling sensor developed by ADAMA innovations, based on fibre-optics interferometry, which provides a resolution of tens of nanometers.



"Final concept of the mechatronic device for in-mould alignment and compensation of geometric tolerances".

4-point Diagram

Poster



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From research to applications

Injection control systems	Injection moulded optical components	Functionalized mould inserts manufacturing
In-mould OCT monitoring	Optical design	Advanced laser micro manufacturing
Data management peripherical mechatronics	Optical quality injection overmoulding	High precision micro milling
In-mould fill control system	Quality inspection system	DLC coating + ion implant lithography

Pilot line assembly and modules integration

Mass manufacturing of embedded optoelectronics with optical functionalities

Novel manufacturing chains for high quality integrated optical devices

Flexible screens

Scanning head for optical encoders

12 partners | 7 countries | 6,7 M€ | 42 months

Adama innovations · aimen Technology Centre · Mondragon Assembly · ceit · Fagor Automation · Promolding · FlexEnable Truly flexible electronics · HYBtronics · CD6 · UPC · RECENDT · Fraunhofer IWU · snelloptics

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