

Presentation of the MONA Nanophotonics Technology Roadmap

New Munich Trade Fair Centre
Sunday June 17, 2007



International Congress Centre
Munich



During Laser 2007 at the International Congress Centre in Munich, a MONA Symposium was held within the scope of the **EOS Conference on Trends in Optoelectronics**.

Goal of the EU MONA project is building a European Roadmap for photonics and nanotechnologies. This session presented the background of the process and the people involved. It gave an overview of the highlights of the roadmap, with time set aside for discussion of the next steps.

A focussed audience of international experts attended following program:

Introduction (Laurent Fulbert, CEA)

Message from the Commission (Dr. Gustav Kalbe, EC)

Applications session / Lighting

MONA roadmap on Lighting (Rainer Beccard, Aixtron)

Industrial Vision (Dr. Michael Scholles, FhG IPMS)

Application session / Information/Communication

MONA roadmaps on Information/Communication

(Dr. André Scavennec, ALCATEL-THALES III-V LAB)

Integration issues in Nanophotonics: ex. PICMOS (Prof. Roel Baets, IMEC)

Nanophotonic Materials session

MONA Materials roadmap (Prof. Roel Baets, IMEC)

Presentation of Phoremest roadmap (Dr. Dirk Holtmannspötter, VDI-TZ)

Equipment session

MONA Equipment roadmaps (Dr. Suvi Haukka, ASM)

Focus on Nanoimprint (Dr. Marc Beck, Obducat)

Discussion on Recommendations (Chairman: Dr. Eric Mounier, Yole Dév.)

Message from Photonics21 (Prof. Małgorzata Kujawińska, Warsaw University of Technology)

Presentation of Synthesis and Recommendations (Dr. Eric Mounier, Yole Développement)

Discussion Round on overall Recommendations with the Speakers.

MONA contacts:

Laurent Fulbert

Tel: +33 4 38 78 38 45

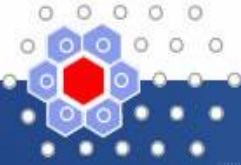
Fax: +33 4 38 78 51 73

laurent.fulbert@cea.fr

Dirk Holtmannspötter

Tel: +49 (0) 211 62 14 - 486

holtmannspoetter@vdi.de



MONA – Symposium at World of Photonics Congress

MONA Symposium Report

In the introduction session, **G. Kalbe** (European Commission) highlighted the importance of roadmaps to identify challenges and set priorities. They are essential for both the European Commission and the photonics community. MONA has to contribute actively to the Photonics21 workgroups to feed the discussions on the Workprogramme 2009-2010. The updated version of the Strategic Research Agenda priorities is expected by December 2007.

In the lighting session, the presentation made by **R. Beccard** (Aixtron) gave an overview of the MONA roadmap. Solid state lighting is clearly driven by the need to reduce cost per lumen and to increase the efficiency of LEDs. These targets can be strongly supported by the implementation of nanophotonic concepts. Amongst the nanophotonic approaches for lighting applications, GaN based LED with quantum dots nanophosphors or photonic crystal light extraction are the more developed. Organic nanostructures and ZnO nanowire LEDs may have high commercial impact. The use of photonic crystals or plasmonic structures is a promising approach; however, severe manufacturing issues have to be overcome. Finally, there are concepts to reduce dislocation densities in III-V LEDs by applying quantum dot structures.

M. Scholles (FhG IPMS) made a focus on OLED lighting and displays. This technology exhibits potential advantages as flexibility, large area and high efficiency. The most critical fabrication challenges are related to lifetime and large area manufacturing processes (in-line fabrication or roll-to-roll). For many of these issues there are promising nanophotonic concepts. Generally, future OLEDs may require more sophisticated structures that will include nanostructures with a high degree of controllability.

In the Information/Communication session, **A. Scavennec** (Alcatel Thales III-V lab) gave an overview of the MONA roadmap. Convergence of photonics and electronics could bring higher functionality while reducing the size and the cost of the devices. Silicon photonics is a very active field, and one of the biggest challenges is to obtain an efficient laser source on silicon. In data storage, near field techniques are the most promising.

R. Baets from IMEC/Gent University presented the results of the PICMOS project. Attention has been paid to the compatibility of the fabrication steps with the CMOS process. Heterogeneous integration of III-V materials on Si leads to the first demonstration of an optical interconnect layer on silicon.

Intermediate results of the Phoremest scientific roadmap for nanophotonics were presented by **D. Holtmannspötter** (VDI Technologiezentrum). These roadmapping efforts appear to be a good supplement to the MONA roadmap as they address longer-term issues relevant to the scientific community.

In the last presentation, the first results of the MONA synthesis has been presented by **E. Mounier** (Yole Développement). Although a lot of photonic devices which might be impacted by nanophotonic have been investigated during the MONA project, the synthesis highlighted some commonalities between devices. For example, if we consider the Display and Lighting applications, the common objective is to generate and distribute light with a high brightness and efficiency. The main devices under development which will be impacted by nanophotonics are LED, CNT Field emission and OLED.

For the 10 years to come, the nanomaterials have been classified according to the expected sales for nanophotonics and the level of required R&D effort to attain the objective.



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MONA contacts:

Laurent Fulbert

Tel: +33 4 38 78 38 45

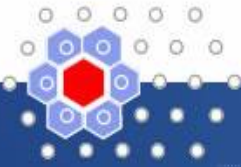
Fax: +33 4 38 78 51 73

laurent.fulbert@cea.fr

Dirk Holtmannspötter

Tel: +49 (0) 211 62 14 - 486

holtmannspoetter@vdi.de



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Following this analysis, it appears that QD and nanowires (III-V and II-VI), high contrast Si and III-V nanostructures, organic and plasmonic nanostructures, CNT and electronic/photonic integration will have large sales.

Regarding equipment, the technologies that will have the highest potential impact on nanophotonics and at the same time will have potential for mass production will be the following: MOCVD, CNT CVD, colloidal synthesis, nanophosphor fabrication, sol-gel synthesis, OVPD, UV lithography, nanoimprint and etching. The types of equipment and processes with the broadest field of applications will be the following: MOCVD, MBE and colloidal chemistry as bottom up technologies and UV litho, e-beam and nanoimprint as top down technologies.

The presentation ended with first recommendations for Europe. Although the position of Europe for nanophotonics devices is not so strong (except for LEDs) and the majority of the manufacturing of semiconductor or photonic devices is done outside Europe, there is a strong equipment industry in Europe.

For each of the key devices, actions would need to be taken to:

- Improve the European Industrial position by supporting the technological transfer from labs to industry
- Answer to nanomaterial challenges
- Support the key related equipment.

At last, a common approach should be adopted for the following applications which have common issues and some common devices:

- Display and lighting
- Optical interconnect and Data telecom.

More details will be given in the final version of the MONA roadmap.



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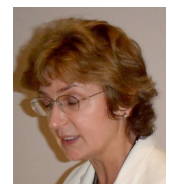
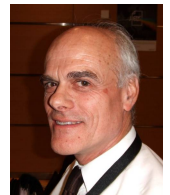
Fax: +33 4 38 78 51 73

laurent.fulbert@cea.fr

Dirk Holtmannspötter

Tel: +49 (0) 211 62 14 - 486

holtmannspoetter@vdi.de



Presenters at the symposium from left to right: Laurent Fulbert, Gustav Kalbe, Roel Baets, Rainer Beccard, Michael Scholles, André Scavennec, Dirk Holtmannspötter, Suvi Haukka, Marc Beck, Eric Mounier, Małgorzata Kujawińska