Computer data at the speed of light

Newsletter 1

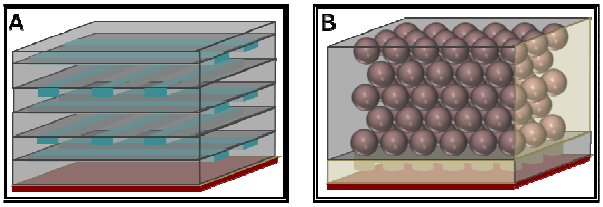
The computational power of high-performance computing systems has been increasing exponentially. As a consequence, the amount of data being transferred between different units of such computing systems has been increasing at a dramatic rate. Optical interconnects, which can reach significantly higher bit rate-distance product density than electrical interconnects, have been replacing their electrical counterparts at ever shorter distances. Therefore, optical interconnects are getting closer to the processor package. It is expected that optical interconnects will be assembled on the board-level and processor package level in the near future.

In October 2011 a new project, named FIREFLY, has started, in which new optical components will be developed, which will make it possible to transmit data in optical domain on the board, along with novel assembly strategies and technologies. The full name of the project is "Multilayer Photonic Circuits made by Nano-Imprinting of Waveguides and Photonic Crystals".

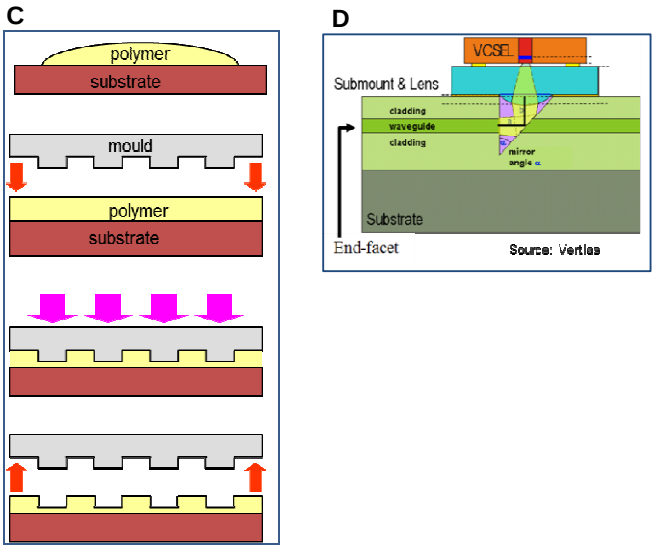
The FIREFLY consortium consists of partners from the industry, IBM Research, TE Connectivity, VERTILAS and Momentive as well as research groups from TNO, imec, VTT, Tyndall and the University of Utrecht.
Materials, processing and device expertise of different partners is combined to develop the nano and micro components needed for the transportation of light using polymer waveguide-based optical interconnects.

Innovative polymers, new applications of nano-technology, new methods for optical coupling between components, and the integration of all these new components are the technical ingredients of this ambitious project.

Expected innovations
New solutions will be developed to make the required optical components:

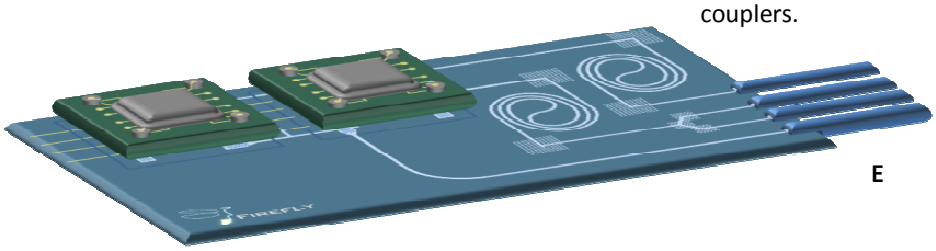


A. Nano-imprinted, multilayer, waveguides of silicone materials with low optical loss.
B. Nano photonic crystalline structures for the sharp bending of light.



C. New, multilayer, nano-imprinting process, making mass production possible.
D. Specific optical components for light coupling, like VCSELs.

E. The new components will then be combined into a Board level Photonic Integrated Circuit. The figure shows two processors including communication with vertical-cavity surface-emitting lasers (VCSELs) to the optical board below them, including four waveguide to fibre couplers.



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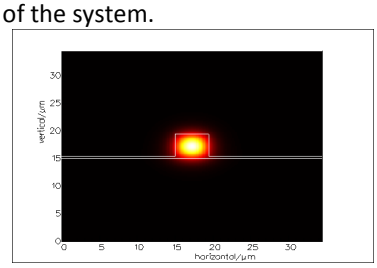
SEVENTH FRAMEWORK PROGRAMME

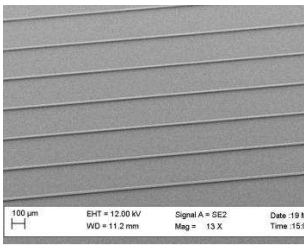
Technical results
After eight months of research and development, the FIREFLY consortium has obtained the following results:

- With the help of the other partners, Imec has designed the lay-out of the first demonstrators to be delivered. The first demonstrators have a relatively simple layout with straight waveguides, one VCSEL and an out-coupling device. The following demonstrators will include bends.

- Modelling activities of Tyndall, TE Connectivity and IBM have provided the required dimensions for the polymer waveguides as well as the power and loss budgets of the system.



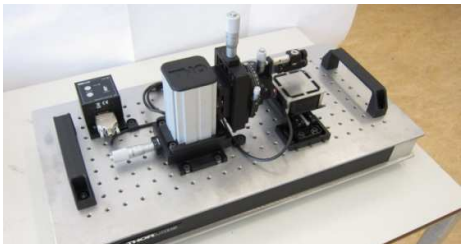
- Silicone materials with relatively low loss have been made available by Momentive, and have been tested by the partners. The experiments focused on refractive index, optical loss and the possibilities of micro-patterning using photolithography and laser ablation. These first material tests showed quite promising results.



- Regarding the photonic crystals, Utrecht University showed some nice first results with monodisperse silica particles.

- Vertilas has started to design VCSELs which are compliant with the requirements for integration.

- TNO presented a new set-up for the deposition of nanoparticles in imprinted substrates.



- VTT is making good progress with the imprinting process, and showed that the silicones indeed can be nanostructures with this process.

From these results it can be concluded that some promising results have already been achieved, but also several challenges are still remaining.

Presentation at SPIE Photonics Europe

On 17 and 18 April 2012 the FIREFLY project was presented at the SPIE Photonics Europe exhibition in Brussels. At the stand, offered to us by the European Commission, the consortium, led by TNO, showed an ongoing presentation with our vision and project objectives. Attendees of the Photonics Europe Conference who visited our stand, were interested in all components that we aim to develop. The future of optics in data transmission was widely recognized.

Bert Jan Offrein (IBM) explained the IBM-roadmap of optically interconnected computers in a presentation at the conference. He mentioned the FIREFLY project which is aiming at one step of the roadmap: the optical data transmission on the optical PCB between components. The process of nano-imprinting, as will be used for preparing the polymer waveguides, was presented by Mikko Karppinen (VTT).

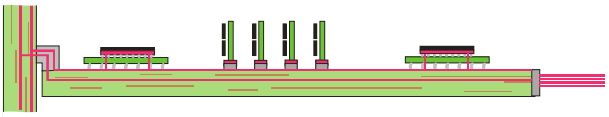


Illustration of optical interconnects on a printed circuit board (shown by the pink lines) as aimed for FIREFLY.

Conclusion
The project has been reviewed in July 2012 with good result, and that a clear focus should be maintained on the material development.

FIREFLY is sponsored by the FP7 ICT program of the European Commission (contract nr 287874).

Website: www.fp7-firefly.eu