Computer data at the speed of light

Newsletter 2 - April 2013

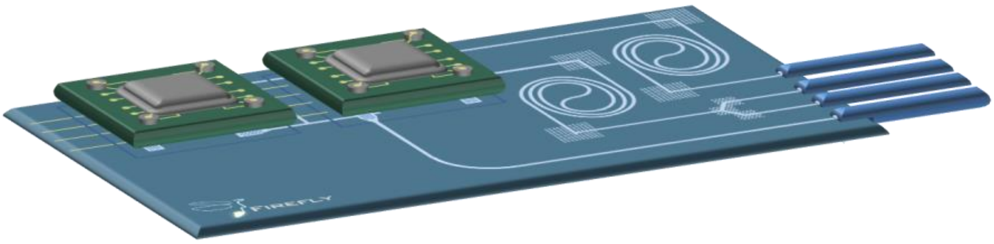
Introduction

In the information and communication industry the performance of microprocessors continues to increase. Consequently, the data flow to and from the processors has to increase accordingly. However, communication becomes a more and more dominant bottleneck for the overall system performance. This has led to the introduction of optical data transmission (e.g. glass fiber) for the replacement of electronic data transmission (e.g. copper wire) in most transmission applications longer than 10 meters. With further development of the information society, there will be a need for even faster data transfer and correspondingly a higher state of integration of electrical and optical components, as is stated in the European Roadmap for Photonics (Mona). To enable such a tight integration between electrical logic and optical communication, new optical materials and structures are required that possess excellent characteristics and can be integrated in a cost effective way.

FIREFLY

In October 2011 a new project, named FIREFLY, has started. In this FP7 project 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 Performance Materials GmbH* as well as research groups from *TNO*, *imec*, *VTT*, *Tyndall* and *Utrecht University*.



Technological objectives

The key building blocks for polymer based optical interconnects are:

- Low loss optical polymers for waveguiding at around 1550 and/or 1300 nm wavelengths
- Waveguide - fiber coupling methods
- Nanostructured photonic crystals for the manipulation of light
- Integration of waveguides with VCSELs
- 'Translation' of current processing techniques to the new materials and components

The selected fabrication technologies are aimed at making more flexible and smaller optical components on a large scale and to reduce their production costs.

Intermediate results

After 1,5 year of research and development, the FIREFLY consortium has obtained a number of intermediate results as presented in this newsletter.

Technology demonstrators

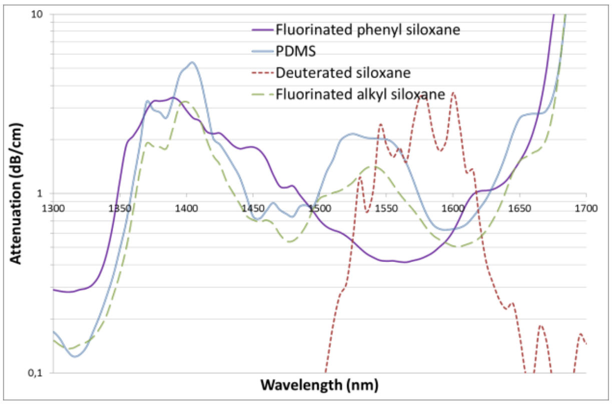
In order to be able to prove the new technologies, some first demonstrators have been defined by Imec. These demonstrators will e.g. show the integration of the single mode polymer wave-guides with conventional glass fibers and VCSELs.

FIREFLY is sponsored by the FP7 ICT program of the European Commission

Low loss silicone materials

There are numerous publications describing polymeric waveguide material systems, including acrylates, polyimides and cyclic olefins. The organic-inorganic hybrid Ormocer® is often used for polymer waveguides and is being used as bench mark in this project. For the materials established in FIREFLY, we focus on a range of parameters, like the costs, processibility and optical loss at 1550 nm for large-area interconnection applications. Momentive is optimizing silicone polymers fulfilling the requirements.

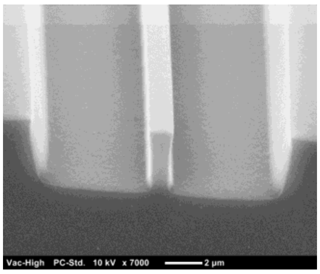
Based on molecular groups which are theoretically favourable for low loss (figure), a new type of silicone is being developed.

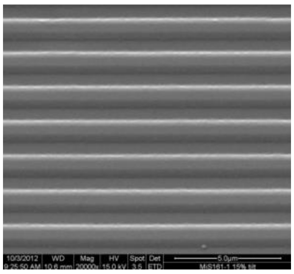


Although not yet there, good progress has recently been made and a new polymer is expected within a few months.

Waveguide preparation

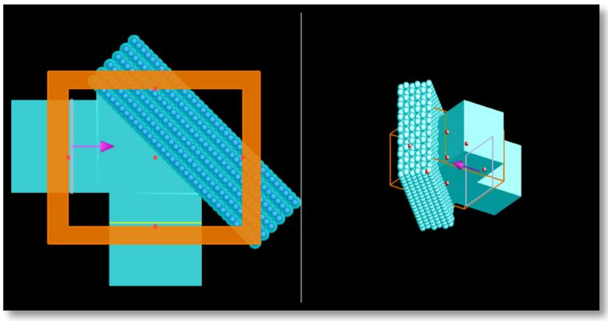
Two technologies are compared for the large scale production of waveguiding structures: Laser direct imaging (LDI) patterning and direct nano-imprint patterning. single-mode waveguides were success-fully processed from Ormocer® materials. The silicone materials, selected by Momentive, had to be optimized, but promising results were obtained by IBM with the LDI technique and imprinting by VTT and TNO (photos).





3D Photonic crystal structures for light bending

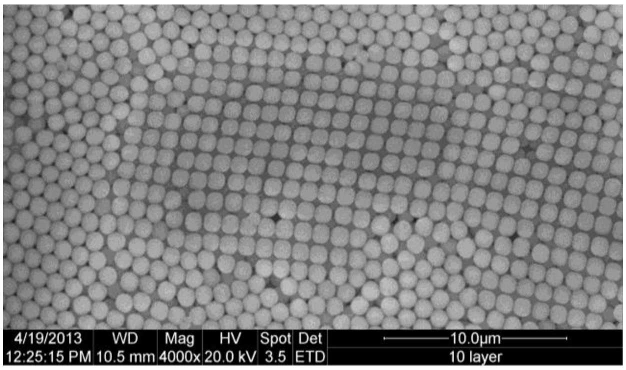
Tyndall succeeded in modeling the light bending effect in 3D photonic crystal structures and calculated the optimal stacking and dimensions for 90° bending of light.



TNO performed experiments for making photonic crystal structures using following components:

- Mono-disperse silica particles made by UU
- Nano-imprinted polymer template made by VTT
- Particle deposition equipment designed by TNO

An example of a particle deposition result is shown in the picture: a layer of 1 µm particles, which are partly regularly stacked in 2D. This process will be optimized and further developed to 3D systems.



Integration of components

For the integration of the components issues like VCSEL mounting, making vias and end-facets, and metal deposition are essential and have been studied by imec, together with TE and IBM.

Vertilas made a first series of specific VCSELs and TE succeeded in making a device for coupling of waveguides and fibers.

Conclusion

Some promising results have been obtained in the first period of the project, which will soon be integrated in technology demonstrators.

More information on: www.fp7-firefly.eu

FIREFLY is sponsored by the FP7 ICT program of the European Commission