FIREFLY

Multilayer Photonic Circuits made by Nano-Imprinting of Waveguides and Photonic Crystals

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Instrument: STREP

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Project Partners:

- Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoez – TNO, NL
- Teknologian Tutkimuskeskus VTT, FI
- IBM Research GmbH, CH
- Momentive Performance Materials GmbH, DE
- Interuniversitair Micro-Electronica Centrum VZW – IMEC, BE
- Universiteit Utrecht, NL
- VERTILAS GmbH, DE
- University College Cork, National University of Ireland, Cork, IE
- Tyco Electronics Nederland BV, NL

Vision & Aim

The objective of FIREFLY is to develop novel polymer waveguides and photonic crystal structures for industrial applications. These structures are based on 3D nano-materials manufactured using new cost effective production processes suitable for large scale manufacturing. The target applications are optical waveguides and photonic structures for the manipulation of light in, for example, optical interconnects. The optical interconnects technology may be applied for data communication in computing systems as well as sensors and consumer-like applications such as multimedia devices.

Figure 1 shows a schematic representation of the 3D structures aimed at. An example of the board level Photonic Integrated Circuit is presented in figure 2.

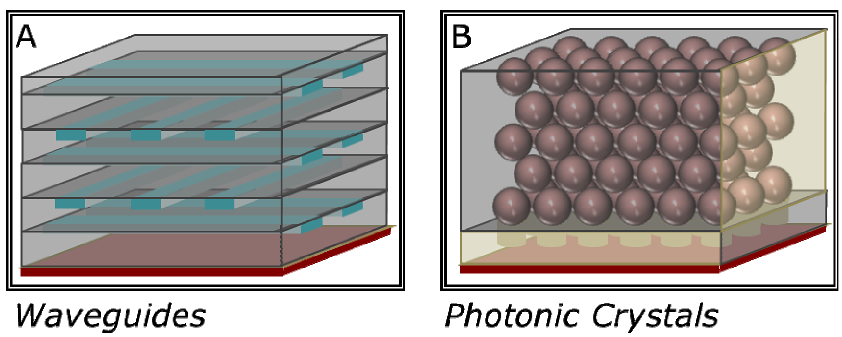

Figure 1. Two concepts for the nanostructured components to be developed in FIREFLY. A) The polymer-in-polymer and B) the particle-in-polymer.

Waveguides and photonic crystals based on polymers have been proven in a laboratory environment to be interesting technologies for light management. In most cases these structures can only be manufactured on small scale. We propose the use of a relatively new technology to manufacture these structures on a larger scale, both in size and volume.

These nano-phased components will be designed using optical modelling, and manufactured by a combined approach of a nano-imprint process in a polymer resin and self assembly of material in these polymer nano-structures. The nano-structures will be filled with new modified polymer compositions having a high refractive index and optical clarity at relevant wavelengths, necessary for waveguides. Inorganic nanoparticles will be integrated in the polymer for optical amplification and to demonstrate photonic crystals that redirect the light through sharp horizontal and vertical bends. The light will be generated by newly developed VCSELs, especially tuned to the applications, which are to be integrated into the light guiding structures. Some material developments are needed: new silicone polymers that will be modified for improved optical properties such as low optical loss and tuneable refractive index, and new inorganic particles that will combine a high refractive index with a very high level of monodispersity.

The manufacturing process will be suitable for up-scaling to an industrial process. This new bottom-up approach will enable the development of new components with tailored optical properties.

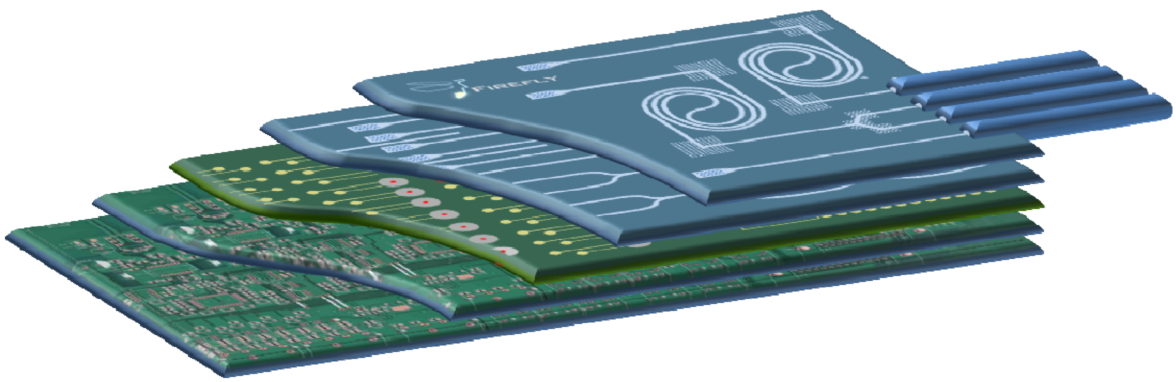

Figure 2. Example of Board level Photonic Integrated Circuit (from top to bottom)

Layer 5: *Horizontal bends, delay lines, active waveguides and fibre couplings*
Layer 4: *Vertical bends; splitters; waveguides*
Layer 3: *VCSEL array*
Layers 1&2: *Conventional electrical PCB with electrical connections*