Realization of first technology demonstrators

June 2013

The FIREFLY consortium has recently produced a number of test chips demonstrating a combination of essential technologies towards its goal of a board level optical transmitter using single mode polymer waveguides connected to an array of single mode optical fibres operating at telecommunication wavelengths (1550nm). The test chips have been produced to answer technological challenges and special care has been taken with developing scalable manufacturable processes which combine the wide variety of materials needed.

The system uses silicon substrates as the platform for the optical circuit. A controlled recess is etched into the silicon to permit a VCSEL to be mounted, embedded and planarised using polyimide. Micro-vias were opened using an excimer laser and the VCSEL electrically connected using copper traces. Subsequently the substrate was planarised with core and cladding layers as used for waveguiding and excellent planarity has been demonstrated. The VCSEL emits 1.5mW at 10mA in the packaged configuration.

Single mode waveguides have been designed both in new silicone materials designed for low loss and controllable refractive index at 1550nm and in a reference ORMOCER system. A mode size of 7μm has been selected in order to minimise insertion loss in connecting between the VCSEL and single mode optical fibres. Straight and in-plane curved waveguides have been realised using wafer-scale imprinting and Laser Direct Imaging (LDI) techniques. A reflecting mirror designed to bend light vertically through 90 degrees has been successfully realised using a novel imprinting technique of an accurately fabricated 45 degree stamp into the waveguide system. The mirror is subsequently coated with gold or silver to enhance the reflection.

A number of techniques have been developed to terminate the waveguides with high optical quality. Dicing and laser ablation have been used for different materials. An alignment block has been designed and implemented to connect an array of single mode fibres to the polymer waveguides. It uses a grooved part in which fibres are attached with UV cured glue and which is aligned to the waveguide array using fiducial marks and connected using a flip chip- tool.

Based on the characterisation of these first demonstrations key questions can be answered and we will proceed to integrate the components to a higher level over the coming months.

Images of embedded and connected VCSEL; (red) light reflection from the imprinted mirror; an imprinted waveguide and fibre blocks connected to polymer waveguide with one channel lit by a red laser.

The work described in this paper was carried out with the support of the FIREFLY-project, a Research Project funded by the European Commission through the 7th ICT-Framework Programme.