

PhD thesis subject :

Technology development for Conformable Lighting Modules and Displays using Flexible OLEDs and Stretchable Interconnects

In today's lighting technology OLEDs play an increasingly important role, as the stability of the devices improves constantly. OLEDs to a certain extent have to compete with LEDs as new light sources. Compared to LEDs they have the big advantage that light is emitted over a large surface. To make large light emitting surfaces with LEDs one has to assemble a large amount of these components on a substrate, resulting in high assembly costs. Also the LEDs are point sources, and do not result in homogeneous light emitting surfaces, unless special light scattering techniques are used. OLEDs can in principle be made as a single light source on a large surface.

There is also an increasing interest in non-flat, curved, or even irregularly shaped light sources. For this purpose LEDs are mounted on a flexible printed circuit board. The same can be done with OLEDs, which can be arranged as a matrix of individual smaller light sources. Applications for flexible light sources include wearable signage (advertising, fashion, safety jackets in traffic, entertainment,...), interior design, but also functional technical light sources on bended surfaces. Next to flexibility, possible already today, random deformability would give additional design possibilities and comfort. Therefore the interconnections between the individual light sources (LEDs or OLED tiles), making up the complete lighting module, should not only be flexible, but to a certain extent also stretchable. CMST is developing the technology for such stretchable interconnects, and first demonstrators, showing a 7 x 8 stretchable LED matrix with silicone (PDMS) as carrier matrix, have been shown. On the other hand the Holst Institute is developing technologies for flexible OLED light sources. It is believed that the combination of both technologies can result in a completely new format and unprecedented design possibilities for light sources. It is precisely the aim of this PhD project to develop the integration technology of flexible OLED sources and stretchable interconnects.

The activities of this PhD could include, but are not necessarily limited to :

- Development of the interconnection technology between OLED modules, using stretchable interconnects. Because of the limited OLED temperature range no conventional soldering can be used. Conductive adhesives will be the first option which will be investigated. The development also includes reliability assessment (mechanical and electrical). A topic is also the further improvement of the reliability of the stretchable interconnections and of the transitions interconnects / components under mechanical load.
- Development of the driving electronics for a "composition" of OLED tiles. The tiles can be arranged as a matrix (in rows and columns), but can also be irregularly arranged (possible thanks to potential random shaping of OLED sources). Optionally for packaging of the driver chips, CMST's Ultrathin Chip Package (UTCP) can be used. This package is <100µm thick, and contains <25µm thick dies which are bendable to a certain extent. If the rigidity of normally packaged driver chips would limit the overall flexibility of the light source, use of UTCP technology could bring drastic improvements.
- The complete light source will be embedded in a stretchable substrate material like silicone or polyurethane. Optical properties of this material can be tuned so that desired lighting effects are obtained. This embedding material should not necessarily be completely flat and transparent, but can be modified by e.g. adding colour pigments, scattering particles, also the surface can be structured (roughness, lens shape,...) so that desired lighting effects are obtained.

- Another activity could include the study of optimal arrangement of OLED tiles, emitting different colours, so that lighting with uniformly changing colour or even multi-colour displays can be obtained. This study could either be limited to simulations, or, in the case sufficient time is available, also functional modules could be built.
- Design and realisation of a demonstrator, in co-operation with a Holst industrial partner.

All developments will be done using available light sources, preferably from Holst, but possibly also from other suppliers. Probably at the start of the project rigid modules will be used, which have a proven stability and production repeatability. In parallel also “dummy” non-functional flexible modules, having interconnections to the outside world, identical to future functional modules, can be used. This will allow developing the interconnection technology before functional flexible modules become available in sufficient quantities for the project. As the technology for flexible OLEDs develops, functional flexible OLED modules can be used for the activities in the PhD project.

Concerning the applications and the demonstrator the PhD will most probably have to concentrate on non-ambulant applications, where sufficient power can be supplied. OLEDs currently have insufficient efficiency to compete with LEDs in the domain of e.g. wearable signage.

The PhD student will also be involved in the EC funded project “Place-It” (Platform for Large Area Conformable Electronics by InTegration) (website : <http://www.place-it-project.eu/>) in Conformable Light sources for medical and automotive applications. The technology, planned to be developed in the frame of the PhD, largely fits with the Place-It work programme.

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Duration : 4 years with a 1 year probation period; immediate start possible.