SU2P *[ěs ū tōō pē]: an innovative bridging project connecting Scottish and Stanford Universities; an industry-academic interaction; entrepreneurial activity in photonics*

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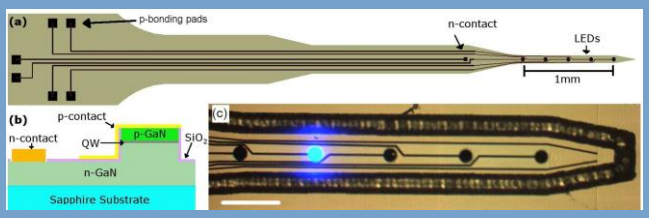

SU2P Pilot Project

Case Study:- Institute of Photonics

Title: Integrated micro-probe systems for optogenetic applications

Objective

The main objective of this SU2P pilot project was to develop and demonstrate an integrated micro-probe system for optogenetic applications. Optogenetics combines optics and genetics to probe and control the activity of individual neurons in living brain tissue so as to understand brain information processing. As an emerging research front, optogenetics will impact the future of research and treatments for brain and nervous systems.. This SU2P pilot project was carried out jointly by the partners in the Institute of Photonics (IOP), University of Strathclyde, mLED Ltd, Stanford University and University of California, Santa Cruz. The successful implementation of this pilot project and significant results achieved have greatly promoted the collaborations between the partners, especially the link with Stanford University.

Project

The micro-probes developed in this pilot project are miniature integrated multiple light sources for in-vivo optogenetic neural stimulation. Currently, the in-vivo neural optical stimulation is made by inserting laser or light emitting diode (LED) coupled optical fibres into the brain tissue. This arrangement has number of major disadvantages. For example, it is not possible to precisely control the distance between the fibres to achieve multiple in-vivo neural stimulations and the setup is expensive. To overcome these problems, this project has successfully developed an inventive micro-probe with integrated GaN based micro-LEDs as multiple micro-light sources for neural stimulation. Our characterisations demonstrate such a micro-probe can deliver light with high spatial and temporal resolutions into deep brain regions.

Summary

In summary, supported by the SU2P programme, we have explored and developed the fabrication techniques to achieve the integrated micro-probes for optogenetic applications. By using these techniques, the micro-probes with integrated multiple GaN LED light sources have been successfully fabricated. The optical and thermal characterizations of the integrated micro-probe show that the on-probe micro-LEDs can deliver enough optical power densities for optogenetic neural stimulation while keeping the average temperature increase in the brain tissue less than 0.5oC. These miniature probes allow spatio-temporal activations of optogenetically targeted neurons and have predominant advantages of on-probe multiple stimulations, precise distance control and selection between the micro-light sources, biocompatibility and low cost. Clearly, these novel optogenetic micro-probes have high potential for commercialization. The success of this pilot project has greatly raised the profile and enhanced the leadership of the IOP and mLED in Neurophotonics and embedded it as a strong theme within SU2P. Recently, a neurophotonics research team has been established in IOP to carry out the high impact neurophotonics research and further develop the integrated micro-probe system for optogenetic applications.