Implantable, Low-Noise, Power-Efficient Neural Amplifier System

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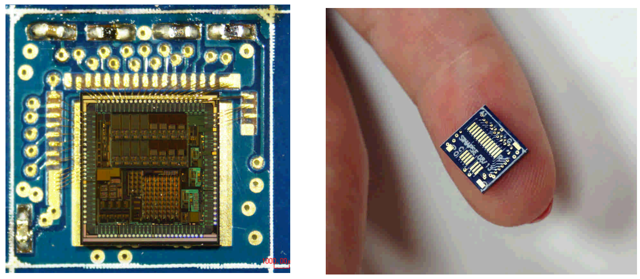
***Abstract*— Neuroprosthetic solutions are gaining popularity in treatment of neurological disabilities and neuronal related diseases. Neuroprosthetic applications such as Brain Machine Interface, cochlear prosthetic implants and others require acquisition and amplification of signals from the nervous system. Such task is usually achieved with the use of neural recording amplifiers. In the case of implantable application, the amplifiers are required to operate at low power to allow extended periods of operation without periodic replacement of power pack as well as restrict heat damage to the surrounding tissues. In this paper, we report a fully implantable system based on our earlier reported neural recording microelectronic circuits and propose future work.**

I. Introduction

Neuroprosthetic solutions are gaining recognition in treatment of several neurological diseases, for example retina and auditory related neural prosthesis. One limitation is the design of a fully miniaturized and implantable neural recording device but thanks to the rapid progress in VLSI microelectronic design and manufacturing techniques, we are now able to fabricate low power yet low noise neural recording amplifier circuits on small silicon chips. Recently we have fabricated low-noise and low power neural recording systems on ICs[1]–[3]. They have been reported to be capable of performing acute in-vivo neural recording. In this work, we extend the capability of these chips to allow them to perform implantable, chronic neural recording on the peripheral nerve system.

II. Implantable Neural Recording Circuits

Our recent works [1]–[3] have demonstrated low power consumption of less than 6 µW and low noise efficiency factor (NEF) of less than 2.58. Further work is now being done to package such chips into a form factor that is suitable for chronic implantation into animal models such as rats and non-human primates. Fig. 1 shows a recent implementation of such encapsulation whereby a single chip is packaged onto a custom designed Chip-on-Board (COB) package. Besides the amplifier chip[1], only four external passive components are needed to form a single COB package measuring just 7mm x 7mm x 1mm. Prior to implantation, we directly attach an intrafascicular electrode (tf-LIFE)[4] as well as external power and interface lines, which are insulated with biocompatible materials such as PFA or PTFE. The full package is then further encapsulated with biocompatible silicone before the implantation.



(a) (b)

Fig. 1 Fully implantable neural recording amplifier package. (a) COB before epoxy encapsulation. (b) After epoxy encapsulation and ready for integration with electrodes

Future Work

This work would be used as a recording vehicle in the project “Peripheral Nerve Prostheses – A paradigm Shift in Restoring Dexterous Limb Function”, aimed at developing an implantable Peripheral Nerve Prosthesis for the treatment of proximal nerve injuries.

References

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