A Shielded Silicon Neural Probe for Higher SNR Performance.

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Introduction

Recently, there have been various approaches to obtain higher SNR (Signal-to-Noise Ratio) neural signals using micro-fabricated electrode arrays for multichannel neural recording (for example, see [1]). To reduce recorded noise level from sources such as power line and electromagnetic interferences, we introduced a conductive shielding layer in the fabrication of silicon neural probe.

Method

A phosphorus-doped polysilicon material was used for the conductive layer as well as the electrode site. The conductive shielding layer was deposited with a thickness of 3,500Å using LPCVD and was located between silicon substrate and the lower triple dielectric layer consisting of $SiO_2/Si_3N_4/SiO_2$ [2], on which the sites and pads were defined. Another triple dielectric layer was deposited on top for insulating purpose. The sites were defined to a dimension of 10um x 10um. Using the developed shielded probe, we performed multi-channel neural signal recording experiments. From the captured neural signals, the noise PSD (power spectral density) and SNR were measured. Then, the results were compared with those obtained using control probe, which is the same probe but without the new shield layer.

Results

The newly developed shielded neural probes showed better noise reduction characteristics against the controls. The noise PSD was reduced from –48dB to –90dB @120 Hz and –62dB to –82dB @60Hz. The SNR, defined as the peak-to-peak level of the neural signal divided by the rms noise level, was increased about an order of magnitude (from 0.8 to 7.4).

Discussion and Conclusion

A typical neural signal recording system employs a 60Hz notch filter. But method of this kind cannot reduce harmonics of the power line noise. The new-shielded neural probe proposed here eliminates such noise from the source. With addition of just one processing step, a dramatic improvement of the signal-to-noise ratio performance of the silicon neural probe was obtained.

[1] Shielding of Flexible Microelectrode Interconnects for Suppression of Artifacts in Neural Prostheses, Thomas Stieglitz *et al.*, 1998, 20th EMBS

[2] A Micromachined Silicon Depth Probe for Multi-Channel Neural Recording, T.H.Yoon *et al*, IEEE Transactions on Biomedical Engineering, , Volume: 47 Issue: 8 , Aug. 2000 ; 1082 -1087