Hydrogel-coated microelectrode array for neural interface

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Recently, hydrogel has been extensively used in various biomedical applications including soft contact lenses, wound healing materials and as a means for controlled drug delivery and release. In this study, we propose to use hydrogel as a novel neural interface. Planar microelectrode arrays were coated with hydrogel in order to improve the quality of the interface and to aid in drug delivery to cells on microelectrode arrays (MEAs).

1 Hydrogel coating on MEAs

A polyacrylamide gel matrix consisting of acrylamide (19:1, 40% acrylamide:bis-acrylamide), in 30% glycerol, 0.83% methylene blue, 0.12% TEMED, and 100 mM Tris Cl (pH8.5) was prepared. Various compositions (12.5, 25, 50, 70%) of acrylamide were prepared to measure the difference of electrochemical impedances after polymerization over microelectrode sites. Nerve growth factor (0.1 mg/ml in PBS) was prepared and added to the hydrogel solution with the concentration of 10% (v/v). The mixture (10 μl) was applied onto MEAs pretreated with Bind-Silane (3-(trimethoxysilyl)-propyl acrylate, acetic acid, dH2O) for 1 hour. Quartz coverslips were used as a backing template during polymerization. Prior to use, coverslips were treated with PlusOne Repel-Silane ES for 30 min, then rinsed in dH2O and dried at room temperature. A treated glass coverslip was placed on top of the hydrogel solution dropped on MEAs. The acrylamide solution was photopolymerized by exposure to UV light for 15 min on a 312nm UV lamp. Following polymerization the backing coverslip was carefully detached from the MEAs and washed a stream phosphate buffered saline (pH7.4) for 10 min to remove any unpolymerized gel solution.

2 Electrochemical Characterization

The impedances of microelectrode recording sites were measured through polymerized hydrogel in order to check if the neural signal can be detected through hydrogel. The impedances of electrode sites covered by various compositions of acrylamide were measured by potentiostat at 1 kHz in PBS. After hydrogel polymerization on MEAs, the impedances were increased by 1.8, 3.4, 10.8, and 57.1 times for 12.5, 25, 50, and 70% composition of hydrogel coating respectively.

3 Neuron culture and neural recording

Poly-L-lysine was patterned onto the surface of hydrogel using microcontact printing. Primary rat hippocampal neurons were applied to hydrogel surfaces and cultured on stamped patterns. Neural signals were successfully recorded from cultured neural networks through hydrogel (12.5% acrylamide) at 21 days in vitro. (Fig. 2)
5 Summary

We showed that hydrogel can be used as a neural interface material with a drug delivery function. Hydrogel coated on MEAs with a low concentration of acrylamide hardly affect the quality of neural recording. In near future, hydrogel could be employed in neural prosthetic devices using its noble properties such as responsiveness to pH, electrical fields, temperature, light, and organic compounds.

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