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Culturing Neurons on MEMS Fabricated P(VDF-TrFE) Films for Implantable Artificial Cochlea*

Hirofumi SHINTAKU**, Takashi TATENO**, Nobuyoshi TSUCHIOKA**, Harto TANUJAYA**, Takayuki NAKAGAWA***, Juichi ITO*** and Satoyuki KAWANO**

**Department of Mechanical Science and Bioengineering, Graduate School of Engineering Science, Osaka University, Machikaneyama-cho 1-3, Toyonaka, Osaka 560-8531, Japan
E-mail: shintaku@me.es.osaka-u.ac.jp
***Department of Otolaryngology, Head and Neck Surgery, Graduate School of Medicine, Kyoto University, Kawahara-cho 54,Shogoin, Sakyo-ku, Kyoto 606-8507, Japan

Abstract

In this paper, we report an *in vitro* study on the biocompatibility of poly(vinylidene fluoride-trifluoroethylene) (P(VDF-TrFE)) films for the implantable artificial cochlea. The implantable artificial cochlea comprises a piezoelectric membrane made of P(VDF-TrFE), platinum (Pt) thin film electrodes, and a silicon substrate which are designed to stimulate neurons in a cochlea and fabricated by microelectromechanical systems (MEMS) and thin film technologies. The biocompatibility of P(VDF-TrFE) film is evaluated by culturing cerebral cortical neurons from rats on it. The fibronectin from human plasma and the collagen from the calf skin are used as the cell adhesion factors. Since neurons extend dendrites and axons from the somata, it is found that the neurons are successfully cultured on the surface of P(VDF-TrFE) films modified both by the fibronectin and by the collagen. Furthermore, it is also found that the neurons are also successfully cultured over the Pt electrode on the P(VDF-TrFE) of the implantable artificial cochlea modified by the fibronectin. Consequently, the biocompatibility and the applicability of the MEMS fabricated P(VDF-TrFE) films and the implantable artificial cochlea are confirmed.

Key words: Biocompatibility, MEMS, Cerebral Cortical Neuron, Medical Equipment, Biomechanical Engineering, Piezoelectric Device

1. Introduction

Piezoelectric materials are promising ones in the field of implantable artificial organs, since they can be used for electric power generators and sensors using the direct piezoelectric effect and for actuators using the inverse piezoelectric effect. For instance, Lewandowski et al.[1] proposed a piezoelectric power generator with a muscle-tendon unit. Platt et al.[2] proposed a self-powered embedded sensor for orthopedic implants. Schubert et al.[3] and Schrag et al.[4] proposed micropumps using piezoelectric actuators for an