Title: Fabrication and testing of a novel biopotential electrode array

Authors: Shun-Tong Chen, Chi-Yu Chu

PII: S0924-0136(17)30338-2
DOI: http://dx.doi.org/doi:10.1016/j.jmatprotec.2017.07.038
Reference: PROTEC 15335

To appear in: *Journal of Materials Processing Technology*

Received date: 5-2-2017
Revised date: 22-7-2017
Accepted date: 30-7-2017

Please cite this article as: Chen , Shun-Tong, Chu, Chi-Yu, Fabrication and testing of a novel biopotential electrode array.Journal of Materials Processing Technology http://dx.doi.org/10.1016/j.jmatprotec.2017.07.038

Fabrication and testing of a novel biopotential electrode array

Shun-Tong Chen[1], Chi-Yu Chu[2]

[1]Professor, Department of Mechatronic Engineering, National Taiwan Normal University
[2]Graduate student, Department of Mechatronic Engineering, National Taiwan Normal University
E-mail: chenst@ntnu.edu.tw

Abstract

This paper focuses on the fabrication and testing of a novel biopotential electrode array for detecting human brainwaves activity signals. A hybrid micro electro-machining process that combines spark erosion with silver deposition to create suitable taper-shaped micropillar and special discharge craters for holding the biopotential electrode in position on the human scalp is proposed. By means of controlling the secondary-electrode wear rate, the required taper-rate (T=1/7) and special surface roughness (Ra=2.9μm) on the designed biopotential electrode are successfully achieved. The trend curves of bottom wear and carbon deposition in the secondary-electrode reveal near linear increases while the residual hole-depth declines with increased machinings. This indicates that the work energy used allows a steady-state wear rate in the secondary-electrode. Silver deposition is conducted to enhance the safety, electrical conductivity of the microprobe array and being antibacterial. Clinical and experimental results demonstrate that the formed biopotential skin electrode with an array of short-tapered pillars realizes quasi-invasive light contact between cerebral cortex and the microprobe. Four brainwave activity frequency signals are confirmed with superior intensity and repeatability to those realized by present-day commercial planar electrodes. Approaches to secondary-electrode formation, traction force testing, novel microprobe formation in batch mode, work capacitance, and pulse current effects, insertion durability tests, and life expectancy tests of the secondary-electrode are all evaluated in detail.

Keywords: Biopotential electrode array, secondary-electrode approach, silver deposition

1. Introduction

Aging populations in many countries have seen a surge in medical technology associated with the diagnosis and treatment of age related illnesses and conditions. Brain activity produces waves that emanate from pyramidal neurons with weak alternate wave-train bio-signals of 0-200μV and 1-30Hz (Khurana, 2014). Some medical reports (Andreassi, 2007, Nidal and Malik, 2014) have shown that the relationship between electrical brainwave activity and criminal behavior can be recorded by electroencephalogram (EEG). This area of research has focused on recognition of particular