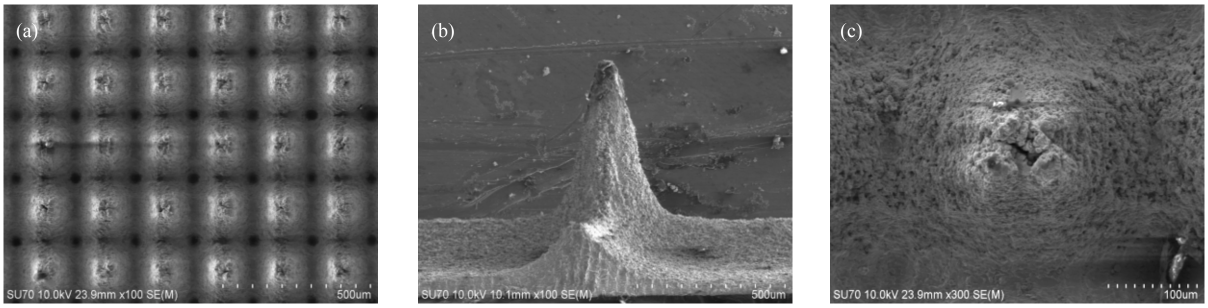
DOI: 10.3969/j.issn.1003-501X.2017.12.006

Fabrication and bacterial adhesion of metal dry electrode with surface microstructure arrays

Shaoyu Liu[1], Wei Zhou[1]*, Yaoyao Li[1], Jiachang Fang[2], Chenying Zhang[1],
Ronghua Lu[1] and Guifeng Ye[3]

[1]Department of Mechanical & Electrical Engineering, Xiamen University, Xiamen 361005, China;
[2]Department of Packing Engineering, Jiangnan University, Wuxi 214000, China;
[3]Department of Orthopaedic Trauma, Zhongshan Hospital of Xiamen University, Xiamen 361004, China



Microstructures on electrode core. (a) Top view. (b) Side view of single microstructure. (c) Surface topography.

Abstract: Biomedical electrodes can convert ion potential of the human body into external electron potential, which are widely used in medical detection and clinical applications such as electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG) and bioelectrical impedance (EIT), etc. Conventional Ag/AgCl wet electrodes usually have conductive gel on its surface and stable signal baseline. However, the conductive gel is easy to gradually dry up and cause allergic phenomenon. Thus, the Ag/AgCl wet electrodes are not suitable for long-time measurement and monitoring of bioelectric signals. Microneedles electrodes can overcome the shortcomings of the Ag/AgCl wet electrode, which can contact the tissue with lower impedance, to improve the quality of bioelectrical signal detection. In this study, the laser milling-recasting technology was proposed to fabricate metal dry electrodes with surface microstructure arrays. Based on the analysis of the microcosmic appearance of the electrode surface, the wettability of the electrode surface were firstly discussed, and then the influence of scanning spacing, scanning speed and scanning times of laser processing parameters on the adhesion of Escherichia coli were further investigated. The results show that the contact angle of metal dry electrode with surface microstructure arrays fabricated with reasonable laser processing parameter could reach more than 150° and showed the superhydrophobic characteristics. With the scanning spacing of 0.1 mm, the smallest averager radius of microstructure on the surface of the metal dry electrode was obtained to limit the biofilm growth, which showed the best performance against the adhesion of Escherichia coli. However, the metal dry electrode adhered more Escherichia coli when the larger scanning spacing was selected. When small scanning times was selected, the metal dry electrodes had much lower height of the surface microstructure, and the larger adhesion amount of escherichia coli was obtained due to its poorer hydrophobicity. With the increasing scanning times, the adhesion amount of escherichia coli of metal dry electrode can be reduced. The scanned speed has little influence on the hydrophobicity and the adhesion ability of Escherichia coli because the shape of the microstructure was not changed greatly with different scanning speeds. Taking into account the performance and economic requirements of the metal dry electrode, the optimized processing parameters including 0.1 mm scanning spacing, 1000 mm/s scanning speed, 15 scanning times and 25 W laser output power were recommend. The metal dry electrode with surface microstructure arrays shows hydrophobicity characteristics against the adhesion of Escherichia coli compared with others bioelectrodes, which have an important application prospects for long-time detection of bioelectricity measurement.

Keywords: metal dry electrode; surface microstructure; adhesion performance; wettability
Citation: Liu Shaoyu, Zhou Wei, Li Yaoyao, *et al.* Fabrication and bacterial adhesion of metal dry electrode with surface microstructure arrays[J]. *Opto-Electronic Engineering*, 2017, **44**(12): 1187-1193.

See page 1187 for full paper.