Fiedler, Patrique; Biller, Sebastian; Fonseca, Carlos ; Vaz, Filipe; Griebel, Stefan; Zanow, Frank; Haueisen, Jens:

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Zuerst erschienen in:	Biomedical Engineering = Biomedizinische Technik. - Berlin [u.a.] : de Gruyter. - 57 (2012), Suppl. 1, Track-E, p. 1083.
Erstveröffentlichung:	2012-08-30
ISSN (online):	1862-278X
ISSN (print):	0013-5585
DOI:	10.1515/bmt-2012-4409
[*Zuletzt gesehen:*	2019-08-12]

Biomed Tech 2012; 57 (Suppl. 1) © 2012 by Walter de Gruyter · Berlin · Boston. DOI 10.1515/bmt-2012-4409

Signal Quality of Titanium and Titanium Nitride Coated Dry Polymer Electrodes

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Introduction

Brain Computer Interfaces, mobile monitoring and Ambient Assisted Living are new fields of application for Electroencephalography (EEG). These technologies require sensors enabling fast and easy preparation as well as mobile and long-term application. Conventional Silver/Silver-Chloride (Ag/AgCl) electrodes are inadequate due to drawbacks arising from the need for electrolyte materials, e.g. extensive skin and electrode preparation, limited application time, and multiple error sources. Novel dry electrodes are intended to be applied without additional electrolyte materials and thus provide the technological base for new EEG applications.

Methods

We designed non-conductive polyurethane substrates comprising 24 pins on a single base plate. The substrate allows for hair layer interfusion while maintaining sufficient electrode-skin contact. The substrates were coated with thin layers of Titanium (Ti) or Titanium Nitride (TiN) using a specific sputtering technique. A multiphase coating process improves the adhesion of the coating. Subsequently, we perform bipolar EEG acquisitions on multiple subjects in order to assess differences in signal quality. Simultaneously acquired EEG signals using conventional Ag/AgCl electrodes allow for an objective comparison.

Results

For all spontaneous EEG tests, including resting EEG, alpha activity and eye movements, a grading is visible when analyzing RMSD and correlation values between the signals of test electrodes and Ag/AgCl electrodes. Lowest RMSD and highest correlation is achieved comparing two sets of conventional Ag/AgCl electrodes. Titanium electrodes exhibit highest RMSD and lowest correlation values in most tests. This graduation is not as clear in the VEP tests as in the spontaneous EEG recordings. Hence, a considerable influence on signal differences could be a different noise level of the electrodes which is reduced during the averaging of the evoked potentials.

Conclusion

Both dry multipin electrodes were applicable for EEG acquisition. However, the TiN based electrodes were much easier to apply and furthermore provided more reliable results as well as increased signal quality.