Methods of trend removal in electrochemical noise data – overview

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Title:

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Abstract:

In this paper we shall review popular methods of trend removal from electrochemical noise time records. The basic principles of operation of the six most popular methods are explained. The proposed methods are: high-pass filtering, Moving Average Removal, polynomial detrending, wavelet detrending, Empirical Mode Decomposition and Variational Mode Decomposition. Estimation of trend removal quality is evaluated using statistical measures like a histogram of noise voltage, power spectral density, the correlation coefficient and signal power. The advantages, disadvantages, limitations and applications of all of the methods mentioned are presented. Two examples of electrochemical noise data with a different nature of generation are used for assessing the efficiency of the presented methods. The first set of measurement data concerning electrochemical noise with a thermal drift were observed during uniform corrosion. The second one refers to noise superimposed on a curve of the discharging current of a supercapacitor. This additive noise component is generated by charge redistribution or redox reactions within porous carbon electrodes. A comparison of these methods and an indication of the most suitable one for removing the drift component from the acquired electrochemical data is summarized in this paper.

Keywords:

Trend removal, electrochemical noise, supercapacitors, homogenous corrosion, thermal drift.

1. Introduction

The determination of the statistical properties of a random time series is of increasing importance in various applications, beginning with the econometric data [1], biological experiments [2], quality prediction for electronic devices [3], gas sensing by low frequency resistive noise [4] or corrosion rate evaluation [5]. When time records of low-frequency noise are considered we may expect that a slowly changing trend component will interfere with that noise and that the precision of estimating its statistical parameters will deteriorate (e.g., power spectral density). Therefore, we have reason to propose an efficient method of trend removal. This issue has attracted numerous scientists and various methods have been proposed to solve it [6–8]. Any of the proposed methods may be considered as an optimal method of to remove various trends and therefore we decided to focus on that problem once again. Moreover, new materials and electrochemical charge storage media (e.g. supercapacitors,