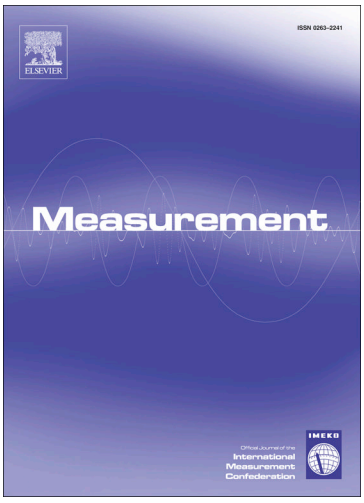

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Non-parametric estimates of the first hitting time of Li-ion battery

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Abstract
Requirements for stable and reliable power sources are almost inseparable part of technical specifications. In this article, we deal with monitoring the capability of Li-ion batteries. We want to determine the time period for which their function will be guaranteed in the course of operation in different operational conditions. These conditions are represented by distinct temperature levels and various discharge currents. Capability monitoring is performed experimentally and mathematically. Within the experiments a decrease in battery voltage is monitored at different ambient temperature levels and discharge currents. Then, discharge courses are modelled and simulated using Wiener processes to obtain a set of time points when the battery voltage drops below a critical value. The first hitting time, i.e., a guaranteed period of an up-state with respect both to given operating conditions and critical threshold, is assessed by non-parametric methods, namely by the kernel density estimation. The results of testing, modelling and simulation provide an interesting picture about Li-ion battery operational behaviour. The outcomes acquired here are applicable in all the technical areas where Li-ion batteries are used and where guaranteed time of the battery safe and reliable operation in various climatic conditions is required.

Keywords
Li-ion battery; testing; capability; soft failure occurrence; kernel density estimation; fault diagnostics