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Advanced Energy Materials

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About the section *Advanced Energy Materials*

The increasing energy demand due to growing global population and the critical relationship between Energy, environment and sustainability lead to novel discoveries and advancement in the field of Energy Materials in search of alternative resources. Energy materials is making ground breaking developments in the science of materials innovation and production. The major significance of Energy helps in strengthening the research and advancement of materials for energy applications. The universal emphasis on energy is to develop materials for energy generation, low energy processing, energy conservation and conversion to meet the increasing energy demand.

Advancing our science and technology, from fundamental breakthroughs in materials and chemistry to improving manufacturing processes, is critical to our energy future. These advances will require a new generation of advanced materials, including:

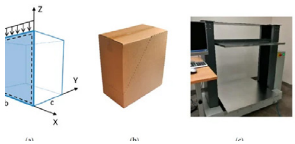
- Energy and Power Materials
- Structural and Multifunctional Materials
- Electronic and Photonic Materials
- Functional Organic and Hybrid Materials
- Bioderived and Bioinspired Materials

Content Highlights

DOI:10.3390/en14041095

Estimation of the Compressive Strength of Corrugated Cardboard Boxes with Various Perforations

Authors: Tomasz Garbowski, Tomasz Gajewski, Jakub Krzysztof Grabski

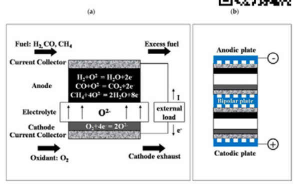


Abstract: This paper presents a modified analytical formula for estimating the static top-to-bottom compressive strength of corrugated board packaging with different perforations. The analytical framework is based here on Heimerl's assumption with an extension from a single panel to a full box, enhanced with a numerically calculated critical load. In the proposed method, the torsional and shear stiffness of corrugated cardboard, as well as the panel depth-to-width ratio is implemented in the finite element model used for buckling analysis. The new approach is compared with the successful though the simplified McKee formula and is also verified with the experimental results of various packaging designs made of corrugated cardboard. The obtained results indicate that for boxes containing specific perforations, simplified methods give much larger estimation error than the analytical–numerical approach proposed in the article. To the best knowledge of the authors, the influence of the perforations has never been considered before in the analytical or analytical–numerical approach for estimation of the compressive strength of boxes made of corrugated paperboard. The novelty of this paper is to adopt the method presented to include perforation influence on the box compressive strength estimation.

DOI:10.3390/en14051280

Progress in Material Development for Low-Temperature Solid Oxide Fuel Cells: A Review

Authors: Mohsen Fallah Vostakola, Bahman Amini Horri

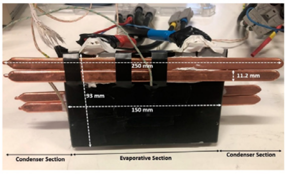


Abstract: Solid oxide fuel cells (SOFCs) have been considered as promising candidates to tackle the need for sustainable and efficient energy conversion devices. However, the current operating temperature of SOFCs poses critical challenges relating to the costs of fabrication and materials selection. To overcome these issues, many attempts have been made by the SOFC research and manufacturing communities for lowering the operating temperature to intermediate ranges (600–800 °C) and even lower temperatures (below 600 °C). Despite the interesting success and technical advantages obtained with the low-temperature SOFC, on the other hand, the cell operation at low temperature could noticeably increase the electrolyte ohmic loss and the polarization losses of the electrode that cause a decrease in the overall cell performance and energy conversion efficiency. In addition, the electrolyte ionic conductivity exponentially decreases with a decrease in operating temperature based on the Arrhenius conduction equation for semiconductors. To address these challenges, a variety of materials and fabrication methods have been developed in the past few years which are the subject of this critical review. Therefore, this paper focuses on the recent advances in the development of new low-temperature SOFCs materials, especially low-temperature electrolytes and electrodes with improved electrochemical properties, as well as summarizing the matching current collectors and sealants for the low-temperature region. Different strategies for improving the cell efficiency, the impact of operating variables on the performance of SOFCs, and the available choice of stack designs, as well as the costing factors, operational limits, and performance prospects, have been briefly summarized in this work.

DOI:10.3390/en14102907

Lithium-Ion Capacitor Lifetime Extension through an Optimal Thermal Management System for Smart Grid Applications

Authors: Danial Karimi, Sahar Khaleghi, Hamidreza Behi, Hamidreza Beheshti, Md Sazzad Hosen, Mohsen Akbarzadeh, Joeri Van Mierlo, Maitane Berecibar

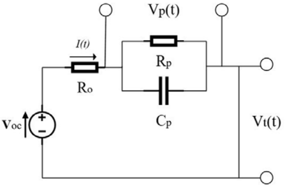


Abstract: A lithium-ion capacitor (LiC) is one of the most promising technologies for grid applications, which combines the energy storage mechanism of an electric double-layer capacitor (EDLC) and a lithium-ion battery (LiB). This article presents an optimal thermal management system (TMS) to extend the end of life (EoL) of LiC technology considering different active and passive cooling methods. The impact of different operating conditions and stress factors such as high temperature on the LiC capacity degradation is investigated. Later, optimal passive TMS employing a heat pipe cooling system (HPCS) is developed to control the LiC cell temperature. Finally, the effect of the proposed TMS on the lifetime extension of the LiC is explained. Moreover, this trend is compared to the active cooling system using liquid-cooled TMS (LCTMS). The results demonstrate that the LiC cell temperature can be controlled by employing a proper TMS during the cycle aging test under 150 A current rate. The cell's top surface temperature is reduced by 11.7% using the HPCS. Moreover, by controlling the temperature of the cell at around 32.5 and 48.8 °C, the lifetime of the LiC would be extended by 51.7% and 16.5%, respectively, compared to the cycling of the LiC under natural convection (NC). In addition, the capacity degradation for the NC, HPCS, and LCTMS case studies are 90.4%, 92.5%, and 94.2%, respectively.

DOI:10.3390/en14020349

Compensation Method for Estimating the State of Charge of Li-Polymer Batteries Using Multiple Long Short-Term Memory Networks Based on the Extended Kalman Filter

Authors: Donghoon Shin; Beomjin Yoon; Seungryeol Yoo



Abstract: Many battery state of charge (SOC) estimation methods have been studied for decades; however, it is still difficult to precisely estimate SOC because it is nonlinear and affected by many factors, including the battery state and charge–discharge conditions. The extended Kalman filter (EKF) is generally used for SOC estimation, however its accuracy can decrease owing to the uncertain and inaccurate parameters of battery models and various factors with different time scales affecting the SOC. Herein, a SOC estimation method based on the EKF is proposed to obtain robust accuracy, in which the errors are compensated by a long short-term memory (LSTM) network. The proposed approach trains the errors of the EKF results, and the accurate SOC is estimated by applying calibration values corresponding to the condition of the battery and its load profiles with the help of LSTM. Furthermore, a multi-LSTM structure is implemented, and it adopts the ensemble average to guarantee estimation accuracy. SOC estimation with a root mean square error of less than 1% was found to be close to the actual SOC calculated by coulomb counting. Moreover, once the EKF model was established and the network trained, it was possible to predict the SOC online.

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