Identifying Degradation Patterns of LI-Ion Batteries from Impedance Spectroscopy Using Machine Learning

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Abstract : Forecasting the state of health and remaining useful life of Li-ion batteries is an unsolved challenge that limits technologies such as consumer electronics and electric vehicles. Here we build an accurate battery forecasting system by combining electrochemical impedance spectroscopy (EIS) -- a real-time, non-invasive and information-rich measurement that is hitherto underused in battery diagnosis -- with Gaussian process machine learning. We collect over 20,000 EIS spectra of commercial Li-ion batteries at different states of health, states of charge and temperatures -- the largest dataset to our knowledge of its kind. Our Gaussian process model takes the entire spectrum as input, without further feature engineering, and automatically determines which spectral features predict degradation. Our model accurately predicts the remaining useful life, even without complete knowledge of past operating conditions of the battery. Our results demonstrate the value of EIS signals in battery management systems.

Keywords : battery degradation, machine learning method, electrochemical impedance spectroscopy, battery diagnosis
Conference Title : ICESMA 2020 : International Conference on Energy Storage Materials and Applications
Conference Location : Tokyo, Japan
Conference Dates : June 11-12, 2020