Introduction:

In the industry sector, the battery has been pervasively deployed for energy storage system, such as emergency and standby supply, electrical vehicle and energy storage power station. Thus, the security of the battery is significantly prominent for the stable operation and long-lasting using of the system, which is directly determined by the battery management. For realizing the management of the battery by an effective, reliable and non-destructive way, electrochemical impedance spectrum, also called EIS, is proposed and explored actively as a research hotspot.

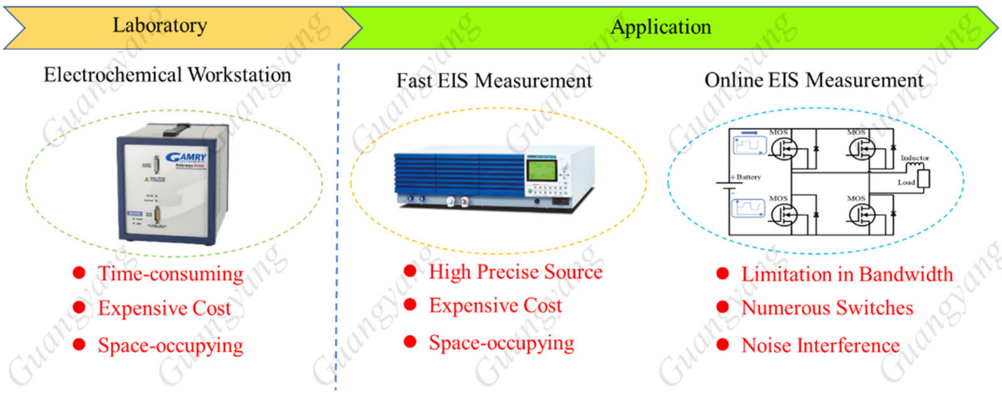


Fig. 1. Different types of EIS measurement

However, even though there is a giant potential in applying EIS for the next generation of the battery management system, how to implement the EIS measurement onboard or online is required to be address. In the beginning, the EIS measurement just can be used in the laboratory by the electrochemical workstation, the process is time-consuming and the device is space-occupying and expensive. But now, influx of substantial researches about application-level impedance measurement mitigates these problems on a large scale. There are mainly two major factions: fast EIS measurement (representative figure: Haifeng Dai, Jinhao Meng and other authors) and online EIS measurement (representative figure: Christos Mademlis, John Fletcher, and so on), which has been depicted in Fig. 1.

Review (In-preparation)

The requirement of application of EIS measurement are fast in time, cheap and space-saving in device, and accurate in result. The three principal aspects of the review are classified and simply exhibited as follows.

Excitation Circuit: independent circuit or functional circuit (balancer, charger and so on) embedded with EIS measurement, and the latter is more valuable due to no extra space for the excitation device;

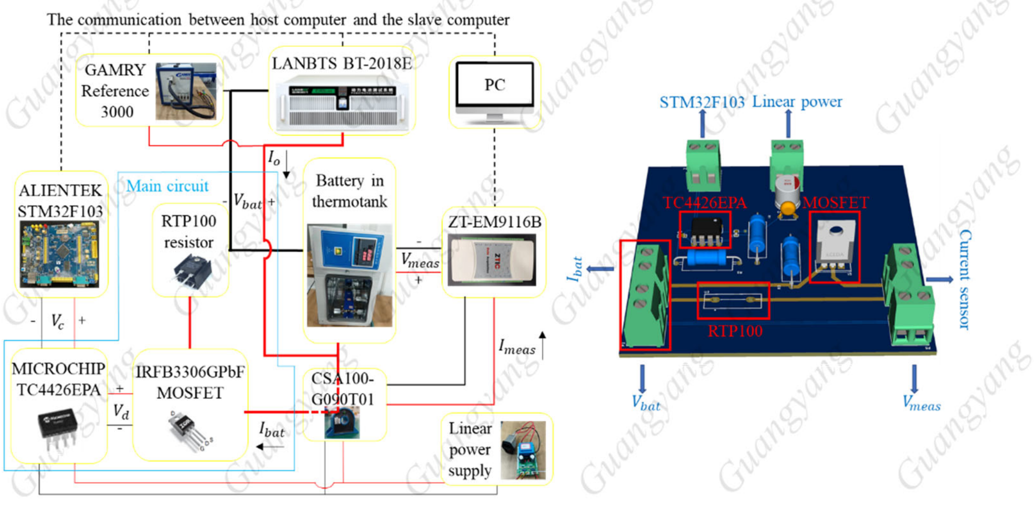
Waveform Injection: broadband signal (Step, Pseudo random sequence and square), multi-frequency signal (multi-sine or Chrip), and current hotspot is broadband signal;

Impedance Extraction: (fast Fourier transform) FFT associated with filter, (short time Fourier transform) STFT, (wavelet transform) WT, and (S-transform) ST

My contribution:

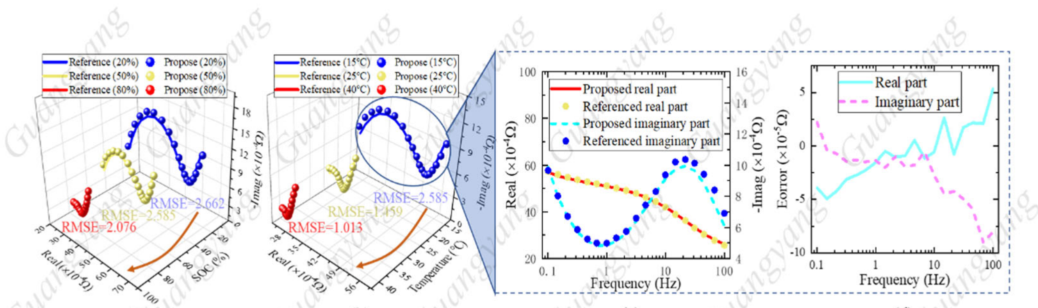
- Invented the discharge paradigm of which the main part of the device is just comprised of one MOSFET and one resistor;

- Modified S-transform by substituting the frequency in the normalized Gaussian window of S-transform (ST) with a linear frequency function for increasing the time-frequency resolution, which is the extension of Morlet waveform transform and S-transform;
- Established an experimental platform and processed the analogous step signal generated by the discharge paradigm to verify the proposed methodology (See figure 2).

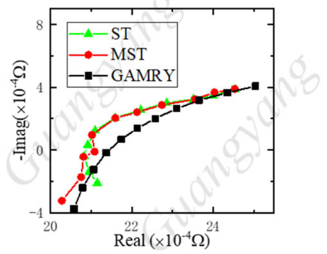


(a) (b)

Exposition of results:



(a) (b) (c) (d)



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