Application Note AN-BAT-008

瑞士万通Autolab DuoCoin电池架,对商用电池进行电化学阻抗谱(EIS)测量

The Metrohm Autolab DuoCoin Cell Holder, shown in **Figure 1**, has been developed to perform electrochemical experiments on coin cell batteries.

The DuoCoin Cell Holder can host up to two coin cells, each of 3.2 mm maximum thickness and 24 mm maximum diameter. Typical coin cell sizes which can be hosted in the DuoCoin Cell Holder are CR2016, CR2020, CR2025, CR2032, CR2325, and CR2330. Each connector of the DuoCoin Cell Holder is directly connected to the battery. Therefore, the leads sensing the potential are separated from the leads carrying the current, resulting in a minimized voltage drop due to the impedance of the wires.

Figure 1. The Metrohm Autolab DuoCoin Cell Holder

In this application note, electrochemical impedance spectroscopy (EIS) is used to test a commercial battery. As comparison, the results from the four-electrode configuration are compared with results from two-electrode configuration, in which the RE and CE leads are connected together, as well as the WE and S leads.

The difference in how the leads are connected results in different measured impedance values.

EXPERIMENTAL SETUP

For the EIS measurements, a Metrohm Autolab PGSTAT204 equipped with a FRA32M module is used (Figure 2).

The battery used for the experiments is a rechargeable Li-ion, Panasonic VL2330, with 30 mAh of nominal capacity and a nominal voltage of 3 V.

EIS potentiostatic measurements are performed at open circuit potential (OCP), between 10 kHz and 100 mHz, 10 mV amplitude, with a rate of 10 frequencies per decade.

Figure 2. The Metrohm Autolab PGSTAT204, equipped with the FRA32M module.

RESULTS AND DISCUSSION

In Figure 3 the Nyquist plot of measurement performed with the four-electrode configuration (red dots) are compared with the results obtained with two-electrode configuration (blue and red dots).

Regarding the two-electrode configuration, EIS measurement is performed with connecting the WE and S leads together and the CE and RE leads together, having therefore the RE and S leads closer to the battery (blue dots). Another measurement has been carried out with the leads connections inverted, so connecting S and WE leads together and the RE and CE together, having the WE and CE leads closer to the battery (green dots).

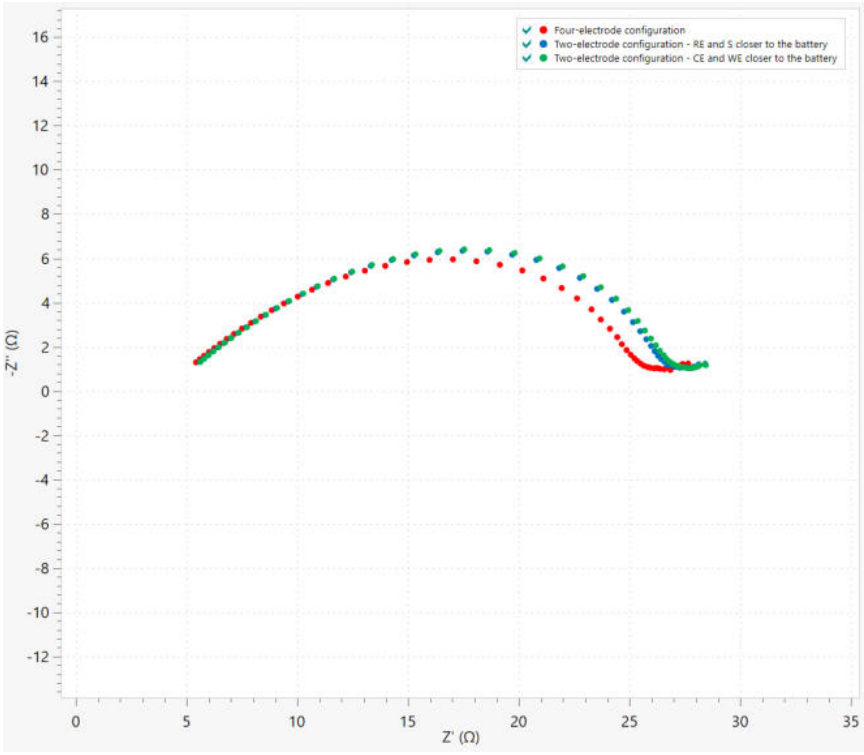

Figure 3. Nyquist plots from EIS measurements performed on the Li-ion battery with four-terminal (red dots) and two-terminal (red dots) sensing configurations.

While there is no appreciable difference between the two-lead configurations, the Nyquist plot corresponding to the four-terminal configuration is shifted towards lower impedance values, with respect to the Nyquist plots resulting from the two-terminal configuration. In **Figure 4**, the magnification at high frequencies of **Figure 3** shows a difference in impedance of approximately 170 mΩ.

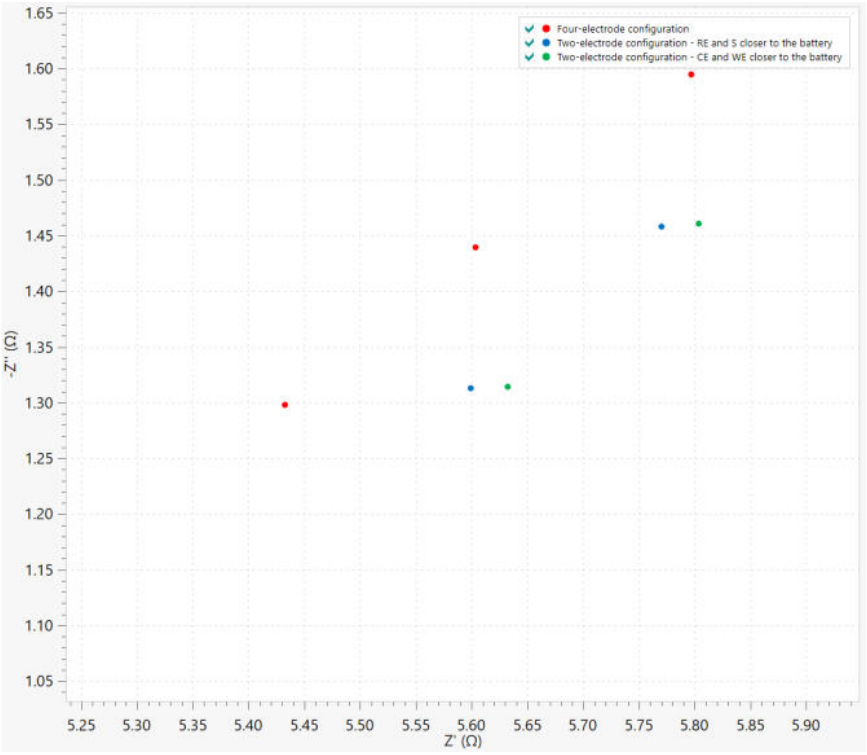

Figure 4. Magnification of Figure 3 at high frequencies.

However, the difference is more evident at low frequencies, as shown in Figure 5, where the difference in impedance between the four-terminal and two-terminal configuration at the end of the semicircle is approximately 2 Ω.

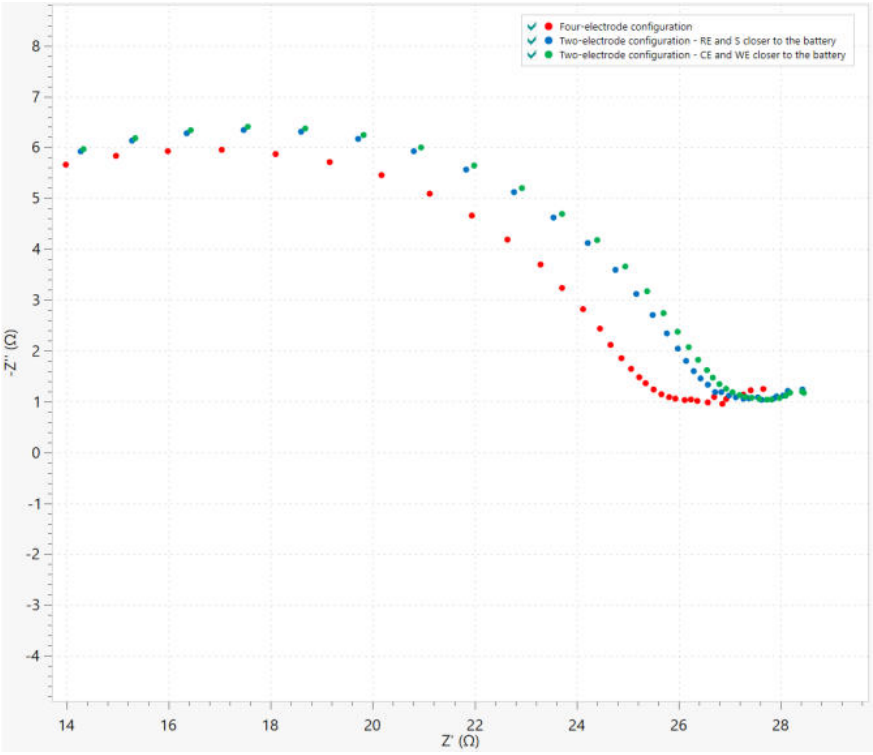

Figure 5. Magnification of Figure 3 at low frequencies.

Finally, it is worth noting that the use of the four-terminal sensing configuration is important only when low-impedance devices are under investigation, like batteries, since the contribution of the wires to the overall impedance is low.

CONCLUSIONS

The DuoCoin Cell Holder is introduced. EIS measurements on a commercial coin cell battery are performed. Differences in impedance between the four-terminal configuration and two-terminal configuration is highlighted, putting in evidence the importance of having a direct four-terminal configuration, when low-impedance DUTs are investigated.

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Autolab PGSTAT204

PGSTAT204 结合了小巧规格和模块化设计。该仪器包括基本恒电位仪/恒电流仪,其顺从电压为 20 V,最大电流为 400 mA 或 10 A,与 BOOSTER10A 组合使用。此恒电位仪可随时用附加模块进行扩展,例如 FRA32M 电化学阻抗谱(EIS)模块。

PGSTAT204 是一款经济实惠的仪器,可置于实验室的任何位置。具有模拟和数字输入/输出,可控制 Autolab 附件和外部设备。PGSTAT204 包括内置模拟积分器。与高性能的 NOVA 软件联用,可用于大多数标准电化学技术。

Autolab PGSTAT302N

该恒电位仪/恒电流仪,具有 30 V 顺从电压,带宽为 1 MHz,可与我们的 FRA32M 模块联用,专门针对电化学阻抗谱而设计。

PGSTAT302N 是流行的 PGSTAT30 的后继款型。最大电流为 2 A,借助 BOOSTER20A 电流范围可扩展至 20 A,当电流范围为 10 nA 时电流分辨率为 30 fA。

Autolab DuoCoin Cell Holder

Autolab DuoCoin Cell Holder 具有 4 点开尔文镀金触头,可为您的电池研究提供较高精度的测量结果 。一个通用附件可适应所有尺寸的标准电化学池以及较小和更大的非标准电化学池,可以一次处理二个电化学池。

Autolab DuoCoin Cell Holder 镀金触头和镀金印刷电路板可防止繁忙实验室中附件的腐蚀和损坏。

Autolab DuoCoin Cell Holder 具有可见电极标签和电缆连接件(与 Autolab 恒电位仪/恒电流仪电缆颜色相对应),可简化实验装置。Autolab 对细节的重视体现在 Autolab DuoCoin Cell Holder 底部的硅表面夹爪上(其可使复杂的实验装置具有稳定性)。

NOVA 是设计为通过 USB 接口控制所有 Autolab 仪器的软件包。

由电化学家针对电化学而设计,集成了超过二十余年的用户体验和最新的 .NET 软件技术,NOVA 使您的 Autolab 恒电位仪/恒电流仪拥有更强性能和灵活性。

NOVA 提供了以下的独特功能:

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- 重要实时数据一目了然
- 强大的数据分析和绘图工具
- 集成化控制外围仪器,诸如万通 LQH 液体处理设备

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