Impedance spectroscopy as a mean to track the capacity evolution of rechargeable gel-based lithium metal battery as a function of both cycling number and temperature.

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For the last twenty years, many researches have been carried out aiming towards the use of metallic lithium as negative electrode for rechargeable batteries. This lead to the development of the solid polymer electrolyte (SPE) [1] PEO-LiX and of battery systems operating at temperatures of about 80°C. To lower the operating temperature of such systems, nowadays intense efforts are devoted to the development of gel polymer electrolytes (GPE) presenting a good conductivity at room temperature. In this work, we present the room temperature performances of rechargeable Li metal battery having a gelled PEO-PVdF-based polymer electrolyte (see e.g. figure 1).

The cycle life and capacity retention of such cells were measured at various temperatures, 55°C, 20°C, and 0°C (see e.g. figure 2). Whatever the temperature, the batteries exhibit a sustained capacity retention during several tens of cycles. Simultaneously, electrochemical impedance spectroscopy (EIS) measurements were performed on the same cells as a function of both cycle number and temperatures. We note that the EIS data track nicely the capacity retention data for different temperatures. More specifically an increase in the resistance, as deduced by impedance, translated by either or both a decrease in cell capacity and capacity retention. To pin down which of the electrode/interface was governing the cell performance we conducted 3-electrodes EIS measurements [2]. We confirmed that the Li/electrolyte interface plays an important role. Nevertheless, we note modification of the lithium interface, depending on the nature of the positive electrode materials used, suggesting that the cathode is not fully transparent to the cell performance.

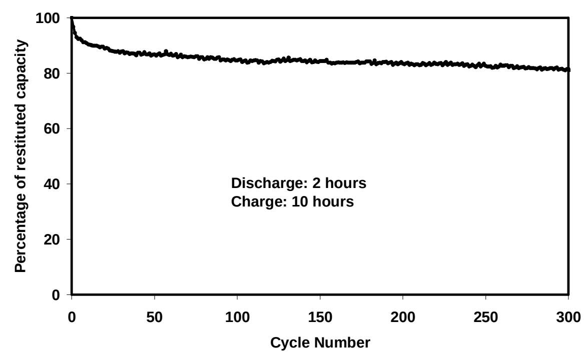

Figure 1: Capacity retention in discharge versus cycle number of a battery operating at room temperature.

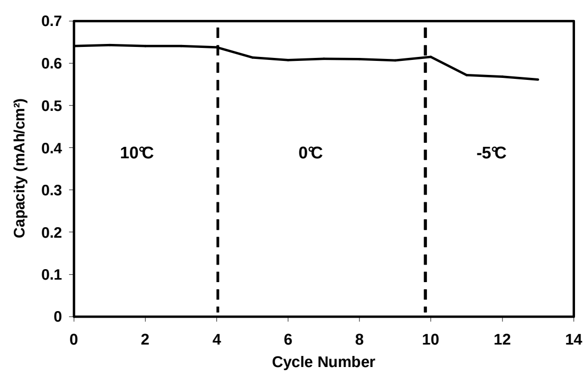

Figure 2: Capacity retention at various temperatures.

[1] M. Armand, J.M. Chabagno, M.J. Duclot, in: P. Vashishta (Ed.), Fast Transport in Solids, North-Holland, New York, 1979, p. 131
[2] Dolle M., Orsini F., Gozdz A. S., Tarascon J-M., J. Electrochem.-Soc. **148** (8) A851 (2001)