Impact of substrate surface preparation method on SEI formation regularities during electrochemical deposition of lithium

Margarita Ryabicheva*, Andrey Kurbatov
al-Farabi Kazakh National University, Almaty 050040, Kazakhstan
*Email: maga050198@gmail.com

The use of lithium metal as an anode for batteries has undeniable advantages because this metal has the most negative reduction potential and the highest theoretical specific capacity. The reduction of lithium metal initially involves processes of solution components decomposition with the formation of SEI - a film of interfacial electrolyte, under which lithium is further deposited. Reversible lithium deposition requires it to have pure ionic conductivity and high mechanical strength.

In this work, the reproducibility of lithium separation on nickel and steel substrates with different preparation of their surfaces was evaluated. The electrodes were polished to a mirror finish, kept in an ultrasonic bath in a 5% KOH solution with 0.01% OP-10, washed with distilled water and dried under vacuum (T = 70°C). Sandpaper (P3000) and a soft cloth were used as methods of cleaning the working surface after CV inside the chamber box (Ar atm.). Cleaning outside the box was carried out with soft cloth followed by washing and drying under vacuum.

Microscopic control of electrode surface along its polishing showed that "mirror shine" is achieved much earlier than ideal surface homogeneity, therefore, in the absence of surface quality control, its homogeneity is unlikely, as well as the reproducibility of obtained results.

A three-electrode cell was used for the electrochemical process of lithium deposition. 0.5 M $LiClO_4$ in propylene solution electrolyte was chosen as the electrolyte. The counter electrode was a platinum plate, and the reference electrode was lithium metal. The water content in the electrolyte did not exceed 50 ppm according to the Karl-Fischer titration method. Research was carried out by cyclic voltammetry (CV), potential sweep was carried out from open circuit potential to -0.2 and -0.4 V (vs Li/Li^+), the sweep rate was 0.1 V/s.

The CV curves obtained on polished substrates show electrolyte decomposition waves, peaks of cathodic deposition and anodic dissolution of lithium. The second cycle obtained without surface cleaning shows only the deposition peak on the curve.

On nickel, a reproducible curve can be obtained only by surface preparation with polishing, other methods do not lead to the necessary surface quality, which causes a significant change in the shape of the CV curve. On steel, the curves differ slightly from each other even with careful polishing, whereas cleaning with cloth outside the box results in sufficient visual surface purification, but the curve differs significantly from obtained on the polished electrode.

In summary, the lack of careful control during substrate preparation makes it impossible to notice surface inhomogeneities critical for lithium electrodeposition.