Influence of Electrodes/Separator Lamination on Structural and Electrochemical Properties of NMC811/Graphite Cells

Daniele Versaci[a], Silvio Fugattini[b], Michele Serri[b], Andrea Moselli[b], Silvia Bodoardo[a]

[a] Electrochemistry Group, Department of Applied Science and Technology (DISAT), Politecnico di Torino, Corso Duca degli Abruzzi, 24, 10129 Torino, Italy

[b] Manz Italy srl, Via S. Lorenzo 19, 40037 Sasso Marconi, Bologna, Italy

E-mail: daniele.versaci@polito.it

With the growing demand for lithium-ion batteries (LIBs), optimizing the cell manufacturing process has become a critical priority. The production of LIBs involves a complex series of sequential steps, each presenting unique challenges. Among these, one of the most impactful at the industrial level is the electrode/separator stacking process, which often includes a lamination step. This process plays a key role in determining manufacturing cost-efficiency as well as the final electrochemical performance of the battery. Hence, a thorough understanding and optimization of the lamination process is essential, not only to reduce production scrap but also to enhance the electrochemical cell properties such as capacity retention and rate capability.

In our study, we conducted a systematic investigation of the effects of two key lamination parameters, temperature and pressure, on the performance of NMC811/graphite full cells. Initially, the influence of lamination on the separator was assessed through permeability tests, ionic conductivity measurements, and morphological analyses. The results revealed a dual effect: lamination conditions altered the porous structure of the separator, leading to changes in both permeability and ionic conductivity. At the same time, concerning the electrochemical evaluation, laminated stacks consistently outperformed their non-laminated counterparts. Cells subjected to optimized lamination conditions demonstrated improved capacity retention during extended cycling at 1C. In particular, higher lamination pressures and temperatures also led to increased initial coulombic efficiency (I.C.E.) and more stable coulombic efficiency over the initial formation cycles. These effects suggest enhanced electrolyte wettability and the formation of a more homogeneous and stable solid electrolyte interphase (SEI). These improvements were reflected in the overall system stability, with lower data variability and improved long-term cycling performance. This highlights the importance of further research on the lamination process, even at a laboratory scale. A deeper understanding of the physical and chemical interactions during lamination, particularly its impact on material interfaces, can drive advancements in electrochemical performance, enable more efficient and cost-effective manufacturing, and significantly reduce production scrap.

Keywords: *lithium-ion battery, lamination process, NMC811/graphite, cell manufacturing*