Numerical Simulation of Electrolyte Impregnation Process in Porous Electrodes of Lithium Ion Batteries

Dong Hyup Jeon¹, Seung Man Baek², Jung Ho Kang², Jin Hyun Nam³


*15 Naeri-ri, Jinryang-eup, Gyungsan 712-714, Republic of Korea
jhnam@daegu.ac.kr

The electrolyte impregnation is recognized as an important process in the fabrication of lithium ion batteries. During the impregnation process, liquid electrolyte is imbibed into the pore space in the porous electrodes to constitute the transport paths for lithium ion. In general, the electrolyte impregnation is driven by the spontaneous action of internal capillary force and external pressure application. Incomplete electrolyte impregnation is expected to significantly limit the performance and long-term stability of lithium ion batteries. The regions of incomplete impregnation do not efficiently participate in the energy storage process. In addition, those regions are believed to be vulnerable to the accelerated degradation.

In this study, the authors numerically investigated the electrolyte impregnation process using mathematical models describing spontaneous and forced imbibition of wetting fluid into porous media. The effects of electrode microstructure, fluid and interfacial properties, and operating conditions on the impregnation process were studied first in a one-dimensional electrode geometry. Then, two-dimensional geometries was studied to clarify the effects of the multi-layer electrode/separater structure in lithium ion batteries on the impregnation process. In addition, Lattice Boltzmann method (LBM) was also utilized to investigate the microscale characteristics of the electrolyte impregnation process.