Effects of electrode surface modification by in-situ polymerization on the electrochemical performance of lithium-ion batteries

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Although the main advantage of lithium-ion battery is its high energy density, the present level is not sufficient to satisfy the requirements of high end applications such as electric vehicles. In order to hurdle this limitation, along with new materials with high capacities, the electrode loading has also to be increased greatly. However, high loading electrode design can cause deficient electrolyte environment near active materials, especially, which are positioned around current collectors. This has been confirmed by our recent work dealing with the effects of electrode loading level on electrochemical performance [1]. Thus, for the electrodes with high loading levels, the electrode wettability towards electrolyte should be highly improved to impregnate sufficient electrolyte into the inside of electrode. Especially, from the previous work [2], the high surface energy of electrode led to poor wetting property. Therefore, the surface coating can be a good approach to give hydrophilicity to the hydrophobic electrodes without any deterioration of pore structure [3].

In this work, the surface of manufactured $LiCoO_2$ cathode film is modified by polydopamine coating. This coating can be achieved by in-situ polymerization with dopamine monomers in water-based medium. For the optimum coating condition, the wettability and electrochemical property are at the same time evaluated. The wettability is checked by contact angle and uptake amount of electrolyte, and the electrochemical properties are investigated with $LiCoO_2$/Li coin cells comprising polyethylene separator and liquid electrolyte of 1M $LiPF_6$ in ethylene carbonate (EC)/dimethyl carbonate (DEC) (1/2, by volume).

[1] J. Choi, B. Son, M. H. Ryou, S. H. Kim, J. M. Ko, and Y. M. Lee, J. Electrochemical Science and Technology, 4(1) (2013), 27

[2] M. S. Wu, T. L. Liao, Y. Y. Wang and C. C. Wan, J. Applied Electrochemistry, 34 (2004), 797

[3] M. H. Ryou, Y. M. Lee, J. K. Park, and J. W. Choi, Advanced Materials, 23 (2011), 3066