Coating of $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$ Cathode on Various Substrates via Slot-Die Coating and Their Performance

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Currently, one obstacle in application of lithium-ion batteries (LIBs) to electric vehicles (EVs) is the high cost. The majority cost of LIBs comes from materials and manufacturing. While cost reduction in materials relies on development of novel materials, the manufacturing cost can be reduced by modifying the current processing techniques. Currently, the manufacturing process of composite electrodes, especially cathodes, of LIBs involves a slurry processing where polyvinylidene fluoride (PVDF) and N-methyl-2-pyrrolidone (NMP) are used as the typical binder and solvent, respectively [1]. Switch the manufacturing process from NMP-based processing to aqueous-based processing enables significant cost saving in electrode processing, and reduced environmental effect [2]. For example, the estimated cost in solvent and associated drying and solvent recovery can be reduced from $38.3 kW/h to $1.46 kW/h when replacing NMP with water as the solvent [3]. However, aqueous processing introduces problems. One of them is the poor wetting of coating on current collector (Al foil for cathode) resulted from the high surface tension of water (72.8 mN/m at 25^{o}C) compared to that of NMP (41,0 mN/m at 25^{o}C) [4].

The work investigates the effect of surface properties of Al foils on $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$ (NMC532) coating properties and performance. NMC532 aqueous suspension was mixed with a planetary mixer and the cathode was coated by a slot-die coater on three current collectors, untreated Al foil, corona plasma treated Al foil, and carbon coated Al foil. The coating quality was characterized by contact angles of the NMC532 slurry on the current collectors and the adhesion between the dry cathode and current collectors. The electrode performance was characterized by electrochemical impedance spetroscopy and cyclability.

The surface properties have significant effect on the electrode wetting and adhesion. For example, Fig. 1 shows the contact between the NMC slurry and untreated and treated Al foil. The contact angle reduced from 83.0^o to 28.5^o when the Al foil was treated by corona plasma improving the surface energy of the Al foil. The adhesion between the NMC532 cathode and Al foil was also increased from 5.7 to 48.6 N/m after corona treatment.

Fig. 1: Droplet of NMC532 slurry on Al foils (a) untreated Al foil and (b) corona treated Al foil.

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