Development of R2R direct gravure coater and Laminate system for Pouch Battery of Electric vehicle

M. S. Yu[1], M. Y. Song[1], H. A. Lee[2] and D. S. Kim[2*]

[1]Department of Creative Convergence Engineering, Hanbat National University, Daejeon, Republic of Korea
[2]TOPnC Co.,Ltd., Daejeon, Republic of Korea

[*]Corresponding author: kds671@hanbat.ac.kr

1. Introduction

The gravure coater has pattern roll so it can be finely contacted with the web. Therefore, it is possible to form the thinnest film among the contact thin film coating technology. It is easy to apply to Roll-to-Roll equipment and has the advantage of continuous mass production. [1]

Lithium secondary battery is the most widely used battery. It is applied to mobile/IT devices and electric vehicles and energy storage system etc. Lithium polymer battery has solid or gel type electrolyte and thus is free of electrolyte leakage with less risk of explosion. Also, this battery has pouch type packaging that allows the battery to be thinner, smaller and lighter. [2] The aluminum pouch is external material of lithium polymer battery and is consists of metal and polymer films. They are laminated by adhesive. [3]

In this paper, we developed Roll-to-Roll laminate system using direct gravure coater and manufactured the aluminum pouch for secondary battery. Finally, establishing the process conditions, we achieved product having the stable property.

2. Experimental

2-1. R2R Laminate system

In this paper, we developed the Roll-to-Roll dry lamination for aluminum pouch. The dry lamination equipment is divided into an unwinder, coating part, drying part, lamination part and winder. In the case of the coating part, gravure coater was applied to give quality and repeatability of the coating. The gravure coater is a concave printing method in which the pattern roll is filled with the coating solution and the doctor blade scrape off the coating solution on the roll surface to enable a uniform coating. In addition, due to the characteristics of the concave printing, the coating pattern and thickness are not changed according to the pressure change of the back-up roll, so that the coating is uniform. Therefore, a highly reliable aluminum pouch was produced using a Roll-to-Roll dry lamination using a gravure coater.

2-2. Manufacturing Process

The aluminum pouch is made by coating a surface treatment agent (trivalent chromium) and an adhesive (polyurethane and polyolefin type) on the aluminum foil, and then laminating it with a nylon film and CPP film. The process is follow as. First, a surface treatment agent is coated on the aluminum foil. After, the adhesive is coated and laminated with nylon film and aluminum foil. At the same method, after coating adhesive, CPP film is laminated with aluminum foil. And aged at a temperature of 85℃ for 4days to form an adhesive force.

3. Results

3-1. Dry Temperature of Surface treatment

In order to achieve stable bonding between metal and polymer, surface treatment agent was coated on aluminum foil to give surface irregularity and to improve adhesive strength according to improvement of wettability. [4] When the drying temperature of the surface treatment agent is less than 100℃, the adhesive strength is remarkably low. (Fig. 1) When the water-based surface treatment agent is dried at a low temperature, the drying of surface treatment agent is insufficient. It is considered that the moisture remaining in the surface treatment agent deteriorates the bonding performance between the adhesive and the adhered. When the drying temperature was 100℃ or more, the adhesive strength was similar.

3-2. Dry Temperature of Adhesive

Proper drying is important since the two-part adhesive exhibits adhesion performance due to volatilization of the solvent. As a result of measuring the adhesive strength according to the drying temperature, (Fig. 2) the adhesive strength was increased with increasing temperature. This is considered to be due to the increase in the degree of volatilization of the solvent as the temperature increases, and thus the adhesion force between the adhesive and the adhered and adhesive agent and the cohesive force in the adhesive are improved.

4. Conclusion

In this paper, we designed the Roll-to-Roll dry lamination system using gravure coater and found the optimal process conditions through process experiment. The property of the manufactured pouch film was similar to those of competitors

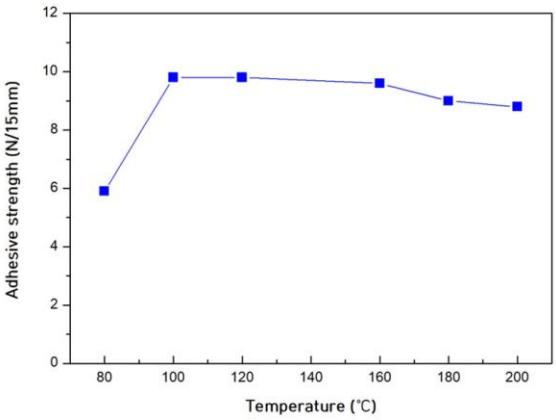

Fig. 1 Adhesive strength by dry temperature of surface treatment

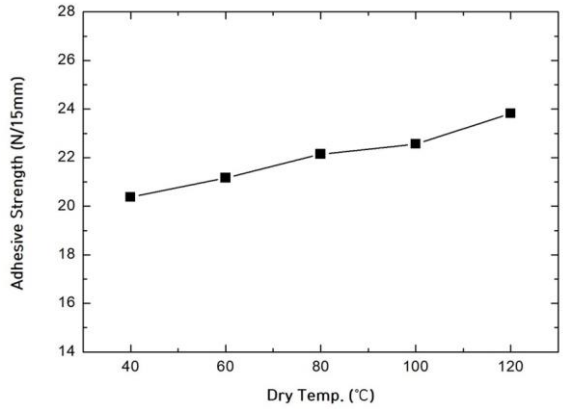

Fig. 2 Adhesive strength by dry temperature of adhesive

(Japan). It was able to manufacture stable products through the manufacturing equipment using the gravure coater, and it is expected that mass productions of the products and localization will be achieved.

Table 1 Process Conditions

Coating process of Surface treatment		
Thickness	Speed	Dry Temp.
< 1um	6m/min	100℃
Coating process of Adhesive		
Thickness	Speed	Dry Temp.
3~6um	18m/min	80℃
Laminate process		
Pressure	Speed	Temp.
130kg	18m/min	60~100℃

Acknowledgment

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MISP) (No.2018R1A6A1A03026005) and supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No.2018M3A7B4071066).

References

[1] Dong Soo Kim, Jung Su Kim, and Sung Woo Bae, “Technology of Thin Film Formation by Using the Micro Gravure Coater,” J.Korean Soc. Precis.Eng., 30(6) (2013) pp. 569-600.

[2] Dong Won Kim, “Technology Trend of Lithium Polymer Secondary Battery,” NICE, 23(4) (2005) pp. 418-420.

[3] HEESUNG CHEMICAL LTD., “Aluminum pouch film for the Secondary Battery, the Pack containing the same, the secondary Battery containing the same and the manufacturing method of the same,” Korea patent, 101381598 (2014) pp. 1-10.

[4] Yeong Sik Kim, Dong Nam Yuk, “Influence of Chromate Coating Conditions on the Surface Appearance and Corrosion Resistance of Aluminum Alloys for Can-stock,” Corrosion Science and Technology, 25(2) (1996), pp.180-191.