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Development of Process and Equipment for Roll-to-Roll convergence printing technology

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The process of manufacturing printed electronics using printing technology is attracting attention because its process cost is lower than that of the conventional semiconductor process. This technology, which offers both a lower cost and higher productivity, can be applied in the production of organic TFT (thin film transistor), solar cell, RFID(radio frequency identification) tag, printed battery, E-paper, touch screen panel, black matrix for LCD(liquid crystal display), flexible display, and so forth. In general, in order to implement printed electronics, narrow width and gap printing, registration of multi-layer printing by several printing units, and printing accuracy of under 20 ㎛ are all required. These electronic products require high precision to the degree of tens of microns - in a large area with flexible material, and mass productivity at low cost. As such, the roll-to-roll printing process is attracting attention as a mass production system for these printed electronic devices. For the commercialization of this process, two basic electronic ink technologies, such as conductive ink and polymers, and printing equipment have to be developed. Therefore, this paper addressed basis design and test to develop fine patterning equipment employing the roll-to-roll printing equipment and electronic ink.

Keywords: printed electronics, roll-to-roll

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디지털 프린팅 용액 공정 소재 개발 동향

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Printed electronics using printing process has broadened in all respects such as electrics (lighting, batteries, solar cells etc) as well as electronics (OLED, LCD, E-paper, transistor etc). Copper is considered to be a promising alternative to silver for printed electronics, due to very high conductivity at a low price. However, Copper is easily oxidized, and its oxide is non-conductive. This is the highest hurdle for making copper inks, since the heat and humidity that occurs during ink making and printing simply accelerates the oxidation process. A variety of chemical treatments including organic capping agents and metallic coating have been used to slow this oxidation. We have established synthetic conditions of copper nanoparticles (CuNPs) which are resistant to oxidation and average diameter of 20 to 50nm. Specific resistivity should be less than 4 μΩ•㎝ when sintered at lower temperature than 250℃ to be able to apply to conductive patterns of FPCBs using ink-jet printing. Through this study, the parameters to control average diameter of CuNPs were found to be the introduction of additive agent, the feeding rate of reducing agent, and reaction temperature. The CuNPs with various average diameters (58, 40, 26, 20nm) could be synthesized by controlling these parameters. The dispersed solution of CuNPs with an average size of 20 nm was made with nonpolar solvent containing 3 wt% of binder, and then coated onto glass substrate. After sintering the coated substrates at 250℃ for 30 minutes in nitrogen atmosphere, metallic copper film resulted in a specific resistivity of 4.2 μΩ•㎝.

Keywords: printed electronics, copper nanoparticles, particle size control