마이크로 사이즈의 전도성 고분자 박막 패턴 형성 연구

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A Study on Micro-patterning of Conducting Polymer Thin Film

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1. Introduction

Transparent electrodes on flexible substrates are essential supporting materials for various applications such as in bendable displays and plastic solar cells. The manufacturing of these devices has made use of a wide variety of processing methods. Among various techniques, researches have been focused on the ink-jet printing because polymer devices fabricated by the ink-jet printing techniques have the advantages of simple fabrication, compatibility with various substrates, availability of non-contact and no-mask patterning, and low cost [1-3].

PEDOT has a low-bandgap polymer (Eg = 1.5eV in the undoped state, where Eg is band gap energy), it shows high electrical conductivity (up to 550 S/cm) in the doped state, and it has good thermal and chemical stability with promising properties for applications such as transparent electrode materials or electronic devices. Therefore, many studies on PEDOT have recently been done to enhance its conductivity and stability and to extend its fields of application [4].

The aim of our study is to apply micro-patterning technic to the electrically conducting polymer (PEDOT) thin film with high conductivity (under 100 Ω/□) and high transmittance above 80% and good thermal stability using a commercial ink-jet printing method. Therefore, we studied types of ink-jet heads, composition of conducting polymer solutions, methods to form patterns and enhancement of their properties. We also investigated various properties of the PEDOT pattern such as optical transmittance, surface resistivity and morphology.

2. Experimental

- materials

EDOT solution was made by mixing a EDOT monomer, DMAc and 1-butanol. 25wt% and 50wt% FTS solutions were made using 1-butanol. Each solution was filtered using a 0.2㎛ PTFE filter to remove a residue.

- Formation of pattern

We formed PEDOT patterns by two different methods. Patterns were designed using Adobe Photoshop software and combination of colors were controlled to print the desired compounds from each cartridge. The first method was to polymerize EDOT monomer by evaporation after ink-jet printing of FTS solution. The flexible substrate with printed FTS pattern was put on a vessel with EDOT monomer for 20 min. And it was dried at 70℃ for 20 min in a oven. The second method was to polymerize EDOT directly on flexible substrates by printing EDOT solution and FTS solution simultaneously. The printed PEDOT patterns were dried at 70℃ for 20 min in a oven. The unreacted monomers, oxidants and reductants were washed with using MeOH.

3. Result and Discussion

Figure 1 shows images and transmittance spectra of printed PEDOT thin film according to the FTS concentration and add to the DMAc. The surface resistivity of PEDOT thin film was decreased with increasing FTS concentration and adding DMAc. Also the transmittance was increased with adding DMAc.

4. Conclusion

We confirmed PEDOT thin film patterns could be formed by a commercially available drop-on-demand(piezoelectric) simple ink-jet printer. PEDOT thin film patterned in this study showed surface resistivity as low as about 150Ω/□ with 80% transmittance at 450nm. Transmittance and surface resistivity of PEDOT thin film pattern were acceptable for practical applications.

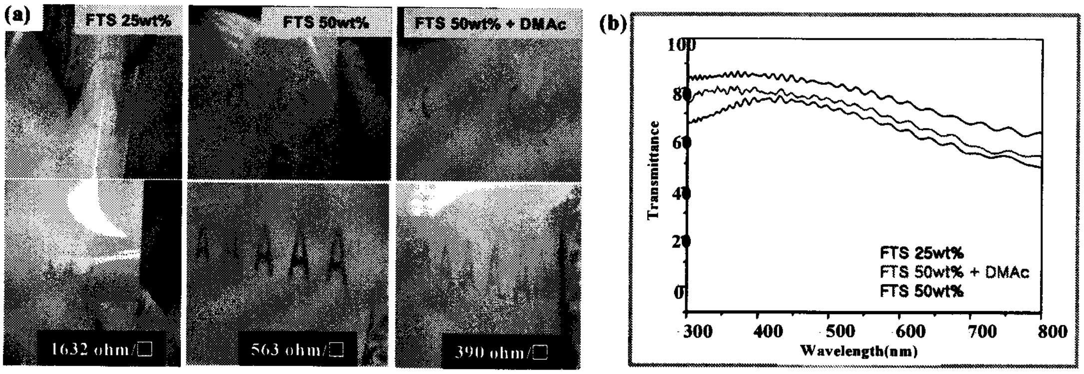

Figure 1. (a) The images of Sungkyunkwan University logo and (b) transmittance spectra of printed PEDOT thin film according to the FTS concentration.

4. Reference

[1] Adv Mater 2001 13(21) 1601-1605

[2] Solid-State Electronics 47 (2003) 1543-1548

[3] Proc. IMAPS 37th Annual International Symposium on Microelectronics Long Beach, Ca, November 14-18, 2004

[4] Journal of Applied Polymer Science, 97, 1326-2332