NOVEL IMPRINTING TOOL FOR ROLL TO ROLL MANUFACTURING OF SUBMICRON STRUCTURES

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Nanoimprinting offers a high speed method to produce low cost devices - at room temperature using functional polymers such as conducting polymers. Patterning of inherently conducting polyaniline (PANI) by nanoimprinting has high potential in fabrication of submicron polymer devices. Decreasing the effective size of polymer-based devices e.g. such as organic thin film transistors (OFET), organic light emitting diodes (OLED) or organic photovoltaic cells [1-6] may improve the performance of devices.

We report on a custom build laboratory scale roll to roll imprinting tool dedicated for manufacturing of submicron structures with high throughput. Polyaniline-dodecylbenzenesulfonic acid (PANI-DBSA) in toluene solution is used as the functional polymer to demonstrate direct patterning of electrically conductive material. The schematic layout of the printing tool is shown in Fig. 1. Three different patterning units; flexographic or FLEXO (F)-unit, gravure (G)- unit [7] and nanoimprint (NIL)–unit are attached sequentially in the tool. This makes it possible to use different printing methods at the same time. The printing speed can be varied from 0.2 meters per minute up to 100 meters per minute. Electrical heaters are installed between printing units for curing the printed polymer.[8]

In the experiments paper or polyethylene terephthalate (PET) substrates are coated with PANI-DBSA by using the FLEXO-unit. Immediately after this submicron features are imprinted by using the NIL-unit at room temperature. The curing of PANI-DBSA can be varied by changing the temperature of the electrical heater or by varying the printing speed. The printing force and speed are optimized for PANI-DBSA. A photograph of the printing system and Ni-stamp attached on a printing cylinder in the NIL-unit are shown in Fig 2.

Roll to roll imprinted PANI-DBSA structures are analysed using optical microscope, AFM and electrical measurements. The PANI-structures are imprinted with a speed ca. 5 meter/minute: The conductivity of imprinted structures is ca. 10 S/cm. Future aspects of roll to roll imprinting of PANI will be discussed.

References:

[1] S.R. Forrest, Nature, **428** (2004) 911.
[2] C.J. Drury, C.M.J. Mutsaers, C.M. Hart, M. Matters, D.M. de Leeuw, Appl.Phys. Lett. **73** (1998) 108.
[3] D.Mecerreys, R. Marcilla, E. Ochoteco, H. Grande, J.A. Pomposo, R. Vergaz, J. M. Sanchez Pena, Electrochim. Acta **49** (2004) 3555.
[4] L. J. Guo, J. Phys. D: Appl. Phys. **37** (2004) 123.
[5] T. Mäkelä, T. Haatainen, J. Ahopelto, H. Isotalo, J. Vac. Sci. Technol. **B19** (2001) 487.
[6] T. Mäkelä, S. Jussila, H. Kosonen, T.G. Bäcklund, H.G.O. Sandberg, and H. Stubb, submitted to Synth. Met.
[6] Y. Cao, P. Smith, A. Heeger, Synth. Met. **48** (1992) 91.
[7] Oittinen, P., Saarelma, H., papermaking Science and Technology Printing
[8] T. Mäkelä al. Unpublished data

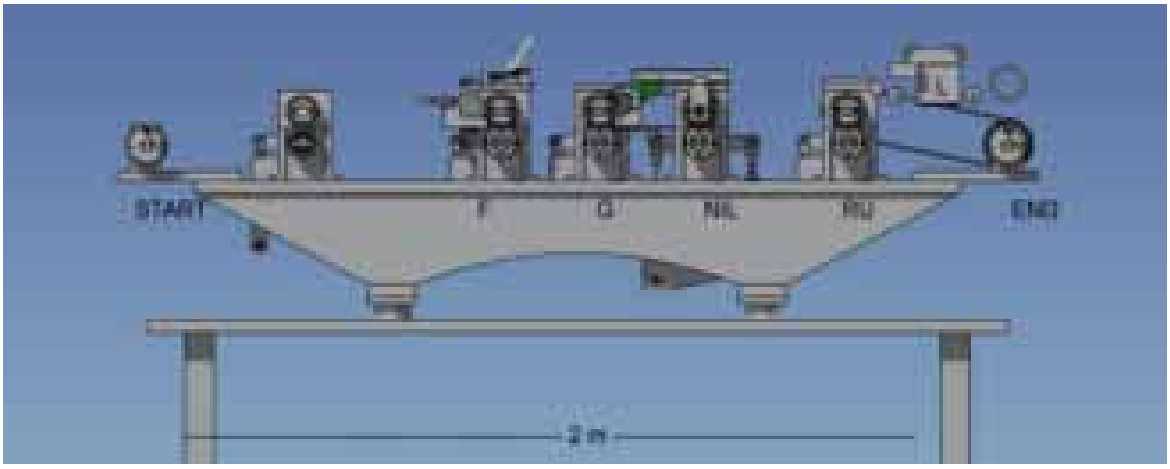

Figure 1. Schematic layout of printing tool for roll to roll manufacturing .

Figure 2. Picture of the roll-to-roll system (left) and closer view of the NIL-unit (right).