# IMPRINTED SUBMICRON STRUCTURES IN INHERENTLY CONDUCTIVE POLYANILINE

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Inherently conducting polymers have been used in several applications for flexible electronics, for example in organic thin film transistors (OTFT), organic light emitting diodes (OLED), organic photovoltaic cells and electrochromic devices [1-3]. Nanoimprinting may offer a high throughput method to produce low cost devices [4] also when functional polymers such as conducting polymers are used. Structures imprinted into conducting polymethylmethacrylate/polyaniline-camphor sulfonic acid (PMMA/PANI-CSA) blend in m-cresol have been demonstrated earlier [5]. However, m-cresol is not suitable solvent for industrial applications due to toxicity and a low evaporation rate.

In this work we investigate the possibility to imprint structures into polyaniline-dodecylbenzenesulfonic acid (PANI-DBSA) in toluene solution. Glass or polyethylene terephthalate (PET) were used as substrates. The electrically conductive 6 wt-% PANI was made by Panipol Ltd in Finland and was used as received. PANI was protonated [6] leading to $PANI(DBSA)_{1.0}$ [7]. Over protonation was used to improve the solubility of the complex.

Viscosity of PANI-DBSA changes when temperature increases and the exact glass transition temperature for this complex is not well defined. Thermoplastic properties for melt-processing are given in Refs. [6,8-9]. In our experiments the imprinting temperature was varied from 20 $^{o}$C up to 150 $^{o}$C and the pressure from 30 to 150 bar to find the optimatized parameters. The residual toluene content in the film has an effect on the behaviour during imprinting and therefore different baking times from few seconds up to 10 minutes at 100 $^{o}$C were tested. 5 x 5 mm$^2$ silicon stamp was used in the experiments with patterns defined by e-beam lithography and reactive ion etching (RIE). The stamp was cleaned with acetone and isopropanol between the imprints.

The imprinting was performed using a commercial pressure cylinder. The silicon stamp was attached to a teflon plate, which allowed the stamp to adjust itself with the substrate. The imprinted structures were analyzed by optical microscope, scanning electron microscope (SEM) and atomic force microscope (AFM). Electrical conductivity was defined by 4-point measurements before and after the imprint process.

An SEM image of 320 nm wide lines imprinted into the PANI-DBSA is shown in Fig. 1. The imprinting parameters were 60 bar pressure and 10 minutes at room temperature. Conductivity of the imprinted structure is ca. 10 S/cm.

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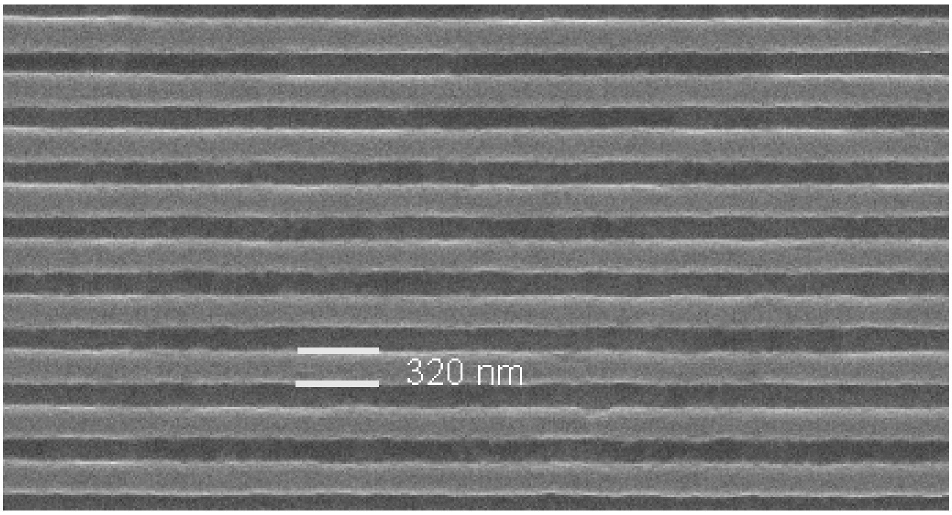

Figure 1. SEM image of 320 wide lines imprinted in PANI-DBSA.