CONTINUOUS ROLL TO ROLL NANOIMPRINTING OF CELLULOSE ACETATE FILM

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Roll to roll manufacturing technique has been a potential for high throughput and low cost production for optics, optoelectronics and organic electronics. Today, roll to roll embossing with submicron resolution is used in manufacturing commercially of, e.g., optical elements.[1] In these cases the resolution is normally limited to a range from a few hundreds of nanometers to microns. Nanoimprinting techniques can be combined with roll to roll process, provided that speed, temperature and pressure are precisely controlled. The approach enables a good way to produce small features at high speed for applications exploiting organic soft materials, thermoplastics and UV-curable polymers.[2-4] Deeper understanding of the flow behaviour of polymers is anyhow still needed.

In this work we have used a custom made laboratory scale roll to roll imprinting machine (Fig. 1) [2] for continuous manufacturing of sub-200 nm trenches on cellulose acetate film. Flexible nickel stamps [5] consisting of 150 – 200 nm wide and 200 - 250 nm high ridges were wrapped around the printing roll and used in the experiments. The speed and temperature in the imprint experiments were varied from 0.2 to 20 meters/minute and from 95 to 110ºC, respectively, while keeping the pressure constant at 8 MPa. In the experiments a 5 cm wide and 95 micron thick cellulose acetate foil (Clarifoil) was used as a web. The imprinted samples were analysed using AFM and SEM measurements.

In Figure 2 is shown the depth of the imprinted trenches as a function of printing speed. Effect of printing speed, i.e., imprinting time on depth is nonlinear which indicates a long flowtime for the polymer.

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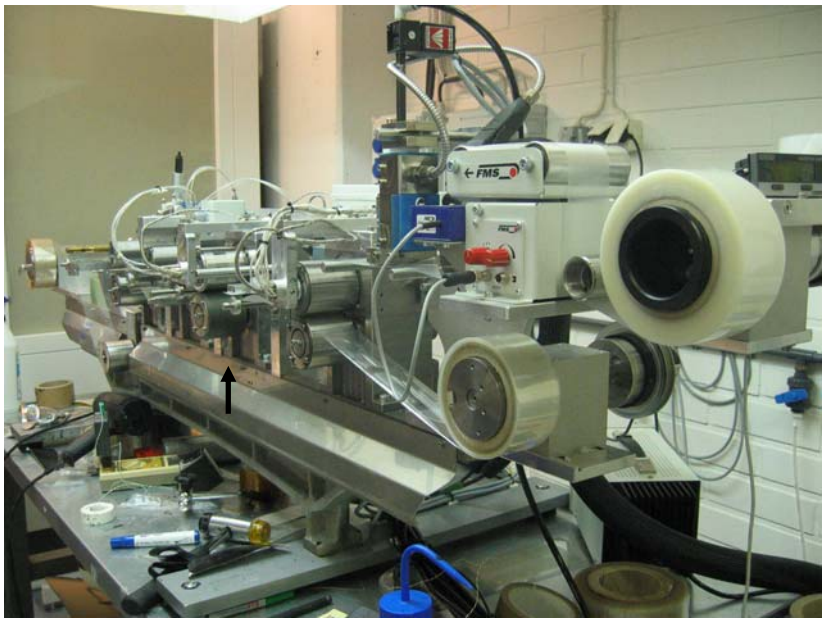

Figure 1. Novel roll to roll imprinting tool where flexo-, gravure- and nanoimprinting units are inline. Imprint unit and nickel shim on roll marked with arrow in image.

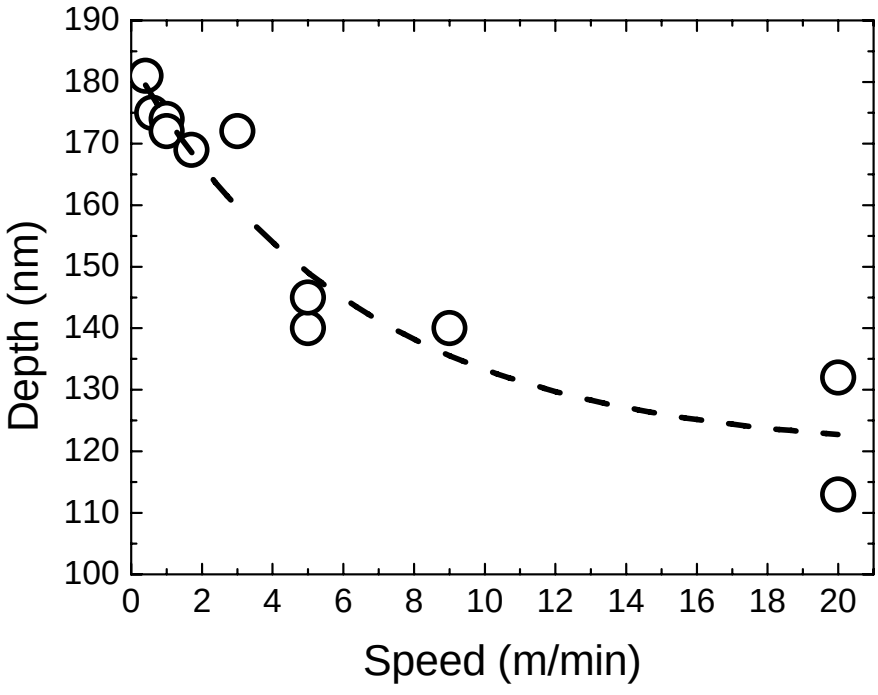

Figure 2. Depth of roll to roll imprinted trenches on 95 micron cellulose acetate as a function of printing speed. The fitted line is first order exponential decay.