Large area holographic surface relief micropatterns by embossing of thixotropic nanocomposite layers on plastic substrates

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A new embossing technique for the fabrication of holographic surface relief micropatterns on plastic substrates has been developed. For state-of-the art embossing techniques with UV curable polymers or ormocers, the curing step has to be performed under the stamper or embossing roll. This leads to rather long processing times and restrictions to fast curing materials like methacrylates. This general drawback could be overcome by embossing of nanocomposite layers with thixotropic behaviour. In these layers, the viscosity decreases with increasing shear rate (imprinting step) and decreases again with degreasing shear rate (removing of the stamper or embossing roll). This allows to perform the UV curing after the removal of the embossing tool.

This new principle for micropatterning is demonstrated with organic-inorganic nanocomposite (Nanomer) layers, prepared from methacrylsilane (MPTS), fluorosilane and ZrO_2 nanoparticles in MPTS : ZrO_2 ratios between 10:1 and 1:2. Wet films of 15 µm in thickness have been prepared by doctor blade coating. After drying at 80°C for 3 minutes, holographic and CD-ROM like pitch patterns have been embossed using an embossing roll of 24 cm in diameter and 35 cm in width with a patterned Ni foil using embossing speeds between 1 m/min and 30 m/min and a final UV curing with about 100 W/cm^2 for 30 s.

By this method, picture holographic patterns with structural depths of up to 350 nm have been prepared on areas of 180 mm x 300 mm and CD-ROM-like pitch patterns with depths of 140 nm have been generated on areas with 120 mm diameter.

The rheology of the dried gel layers, the refractive index and the UV-curing behaviour of the Nanomer material are discussed as a function of the size and concentration of the ZrO_2 nanoparticles.

This new technique offers very interesting prospects to cut down the processing time of CD-ROM-patterns, prepared by injection moulding by more than 1 order of magnitude.

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