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# DEVELOPMENT OF OPTICAL COATINGS ON PLASTIC FOIL, BASED ON NANO COMPOSITES

M. Mennig, M. Jilavi, P.W. Oliveira, A. Berni, D. Anschütz, H. Schmidt
*Leibniz-Institute for New Materials, Saarbrücken, Germany*

A new continuous roll-to-roll coating technique for plastic foils has been developed for the preparation of dielectric interference multilayer systems. Such interference multilayer systems on plastic foil like anti-reflective coatings, near-infrared reflective or visible light reflective coatings have an interesting application potential in the field of displays and also as laminating foils for flat glass in the architectural or automotive sector.

The coating sols consist of $SiO_2$- and $TiO_2$ nanoparticles respectively with polymerizable surface ligands like epoxysilanes or epoxide resins, disposed in isopropanol. The coatings are prepared using a 60 cm wide coating line, running with a line speed of about 1 m / min under clean-room conditions. As a coating technique, an offset-reverse coating setup using polished stainless steel rolls is investigated. The coatings are dried and cured within 2 min at 130° C. The homogeneity of the coating thickness is characterized by vis-reflectance spectroscopy. As examples, a 2-layer antireflective coating with a residual reflectance < 1 % and a 3-layer antireflective coating with a residual reflectance < 0.5 % on triacetate (TAC) foil is presented. Furthermore the preparation of a 3-layer green filter and the design of a NIR reflectance filter is shown. The durability of the multilayer system is investigated by steel-wool scratch tests and different climate tests.

I a second example, a new class of a thixotropic coating for the preparation of digital optical micropatterns on plastic foils is introduced.

The coating is prepared from surface modified $SiO_2$ nanoparticles in an epoxysilane derived matrix. The rheology of the almost solvent free coating sol can be controlled by the concentration and also by the zeta potential of the $SiO_2$ nanoparticles, which can be adjusted between –5.0 mV and –14.7 mV by the addition of tetra hexyl ammonium hydroxide to the colloidal $SiO_2$ suspension.

For the embossing experiments, coatings with 60 wt. % of 10 nm $SiO_2$ nanoparticles were used. Ni-shim stamper with a digital pattern of 0.3 – 1 µm in depth was used. The curing time delay, e.g. the time span between removing of the stamper and the final UV curing of the embossed micropattern, was varied and the quality of the embossed hologram was investigated by a real-time diffraction efficiency method. A diffraction efficiency of 27 % was obtained which did not decrease within 45 h before the final UV curing. This is by far enough to separate the embossing from the UV-curing step and therefore, the new nanocomposite coating is suitable for high speed embossing processes.

In a second step, the embossed and UV cured micropattern is planarized using a $TiO_2$ nanoparticulate coating sol. Since the refractive index difference between the embossed material and the $TiO_2$ cladding of 0.43 is similar to the one between the embossed material and air (0.47), the diffraction efficiency of the planarized micropattern remains high (24 %). The excellent mechanical, chemical and thermal durability of the micropatterns are demonstrated quantitatively.

(Key words: roll-to-roll coating, interference multilayer systems, nanoparticles, polymerizable surface ligands)