

Impact of the resist properties on the antisticking layer degradation in UV nanoimprint lithography

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Nanoimprint lithography (NIL) is one of the most promising new technologies for fabricating patterns with high resolution at a high throughput and reasonable cost. One of the key challenges in NIL is to prevent resist adhesion to the template's surface. Different strategies may be adopted for this goal, focusing on the template surface (treating it with a fluorinated anti-sticking layer, ASL) and or on the resist chemistry (adding surfactant to the resist formulation).

To improve the understanding of adhesion issues in UV assisted nanoimprint lithography (UV-NIL), both resist chemistry and resist mechanical properties were investigated in this work.

In a first time, we compared the impact of the number and type of polymerizable groups of UV curable monomers on the evolution of the mold's surface energy after repeated imprints. The monomers adopted have all the same triethylene glycol chain but different ends of chain, including functions that react by free radical polymerisation such as methacrylates (mono- and di-functional), acrylates (di-functional) or by cationic polymerisation like vinyl ethers (di-functional). To insure a reliable comparative study, the same free radical photoinitiator was used in the case of methacrylate and acrylate-based resists. Besides, for each UV-curable resist, the exposure dose was chosen in order to reach the same degree of conversion (measured by Fourier Transform Infrared Spectroscopy FTIR as illustrated in Fig. 1). Finally, the mold's surface has been treated with *Optool DSX*.

The mold's surface energy was then monitored, using contact angle measurements, as a function of UV imprints number. Fig. 2 shows that, at the same degree of conversion, the di-vinyl-ether resist provokes a higher degradation of the ASL than the di-acrylate, degrading more than the di-methacrylate, degrading more than the mono-methacrylate. Differences may be explained by the different chemistry involved (free-radical systems seems to degrade less than cationic ones) and by the different chemical reactivity (the more reactive acrylates degrade more than methacrylates). In a second time, we made variable the UV exposure time for two types of free radical type resists. Fig. 3 and 4 shows that the higher the exposure dose is, the quicker the ASL's degradation is. These observations are in perfect agreement with our previous work where Electron Spin Resonance analysis has proven that free radicals of the resists are responsible for the premature ASL's degradation [1].

Finally, as the studied resists differs in terms of mechanical properties (mono-methacrylate monomers create linear polymer chains while di-acrylate photopolymerisation systems lead to cross-linked networks), one has to take into account the possible mechanical interaction between resist and mold's surface. This study is ongoing and first results (see Table 1) show significant difference in terms of resist elasticity as a function of the UV-curable resist composition.

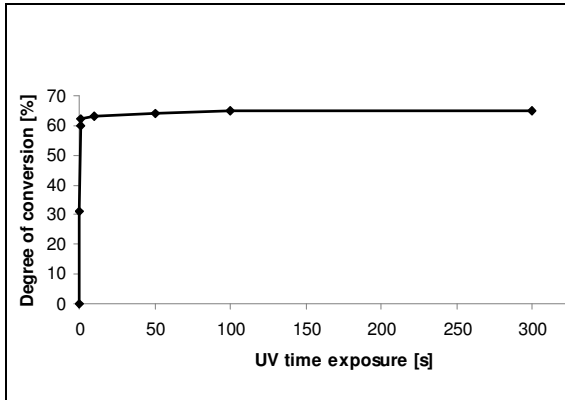


Fig. 1. Degree of conversion for a di-acrylate monomer as a function of UV time exposure obtained by FTIR measurements

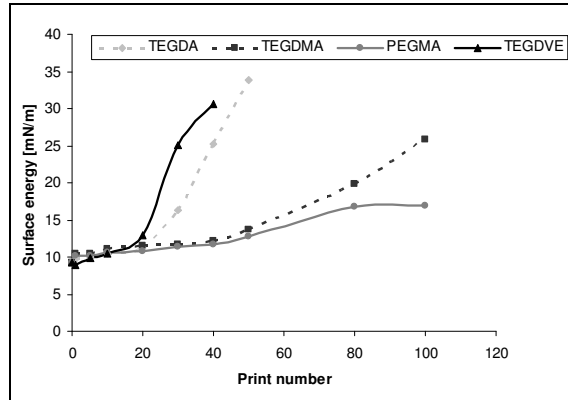


Fig. 2. Mold surface energy evolution as a function of print number measured by contact angle for the different kind of photo-curable monomers (TEGDA = di-acrylate, TEGDMA = di-methacrylate, PEGMA = mono-methacrylate and TEGDVE = di-vinyl-ether) and at a similar degree of conversion

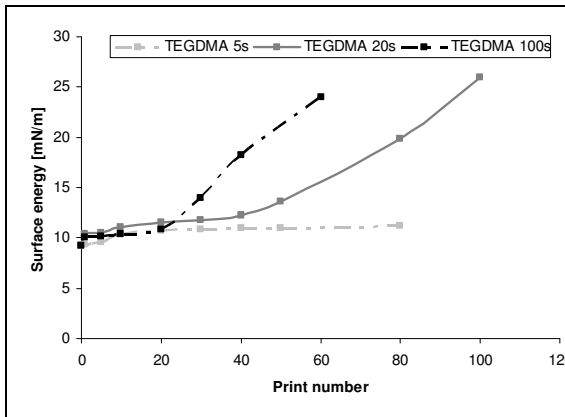


Fig. 3. Mold surface energy evolution as a function of print number measured by contact angle for different UV exposure times (per imprint) in the case of the di-methacrylate resist

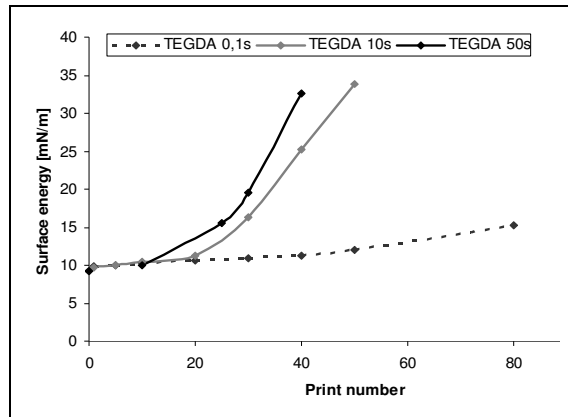


Fig. 4. Mold surface energy evolution as a function of print number measured by contact angle for different UV exposure times (per imprint) in the case of the di-acrylate resist

Resist	E [GPa]
TEGDA	2.3
TEGDMA	2.4
TEGDVE	0.6
PEGMA	0.2

Table 1. Young modulus (E) values as obtained by nanoindentation for the four studied UV-cured resists. Nanoindentation measurements have been performed at a similar degree of conversion for each sample