Reducing the risk of failure with flexible composite stamps

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Abstract

Flexible composite stamps are interesting for thermal nanoimprint as well as for UV-assisted nanoimprint as they provide conformal contact to a substrate without the need of applying high pressure. However, they are also prone to bending when handled during mounting, contact establishment and separation after the imprint step. As they consist of different materials bonded together, internal stresses during bending may lead to stamp failure, typically rupture of the top layer. In order to minimize the risk of failure, the stress within the top layer must not go beyond the material-inherent tensile strength, which, for materials typically used to prepare the top layer, often is not available and may depend on the layer thickness and the specific preparation of the composite stamp. Minimization of the maximum bending stress is therefore required to reduce the risk of failure with flexible composite stamps. Such minimization is obtained easily by controlling the position of the so-called 'neutral plane'. Stresses are highly reduced when the neutral plane is located near the interface between top layer and backplane. We address this issue experimentally as well as theoretically. Diligent choice of the layer thicknesses in combination with the modulus of the materials involved is required to implement this concept. The results obtained confirm the suitability of 'neutral plane management' for minimizing the risk of failure with flexible composite stamps.