Adding 3D shape control in LIFT with *print-n-release*

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Laser-based techniques enable unprecedented versatility and speed in the fabrication of optoelectronic systems. Among them, laser-induced forward transfer (LIFT) stands out as a direct-write bottom-up approach for contact-free printing across a wide range of materials, from solids to liquids. The latter is particularly interesting given that highly viscous liquids and high particle-content inks can be printed with LIFT, something not possible with standard technologies such as ink-jet printing. Still, as with any other liquid-based technique, the three-dimensional (3D) shape of the LIFT-printed structures is determined by the wettability between liquid and substrate. As a result, the fabricated structures exhibit a fixed geometry in terms of contact angle or aspect ratio. This can strongly constrain the flexibility of LIFT in printing user-defined optoelectronic components, including microlenses or electronic circuit lines.

Here we introduced *print-n-release*, a recently developed method for printing structures beyond the limits imposed by substrate-liquid wettability[1]. The central idea is to print on top of pre-stretched substrates. Provided pinning of the contact line, the printed structures can undergo controlled contraction upon the relaxation of substrate stress, all while maintaining their original shape. Thus, by adjusting the initial elongation of the substrate, on-demand control of the contact angle of drops and the thickness of printed lines can be achieved. We demonstrated the feasibility of *print-n-release* by printing microlenses featuring an impressive increase in contact angle of up to 400% and a decrease in focal length down to 90% compared to traditional LIFT, as shown in Figure 1(a). We also fabricated conductive silver tracks with an increase in aspect ratio of up to 800% (Figure 1(b)). Our results are a promising step toward the printing of materials with customized 3D shapes.

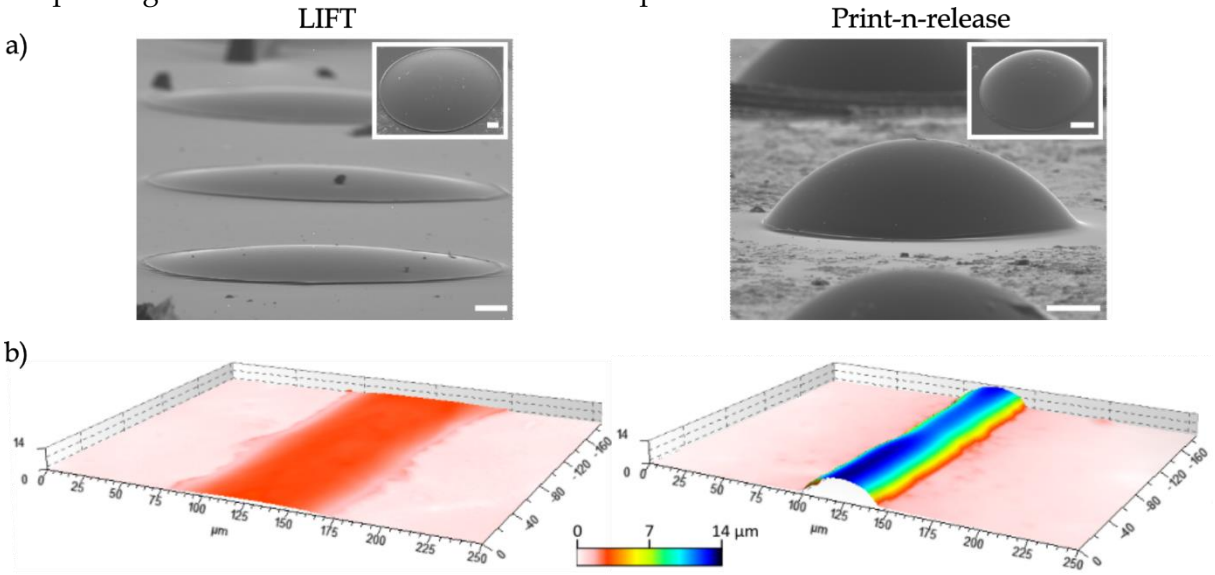

Figure 1: Comparison of traditional LIFT (left) with *print-n-release* (right) for: a) microlenses (SEM micrograph) and b) silver lines (3D profile). Scale bar of (a) is 20 µm.

[1] E. Martí Jerez, J. M. Fernández Pradas, P. Serra, M. Duocastella, *Adv. Mater. Technol.* **2023**, *2300564*, 1.