LIFT of metallic interconnections and solder materials for the digital bonding in photonic applications

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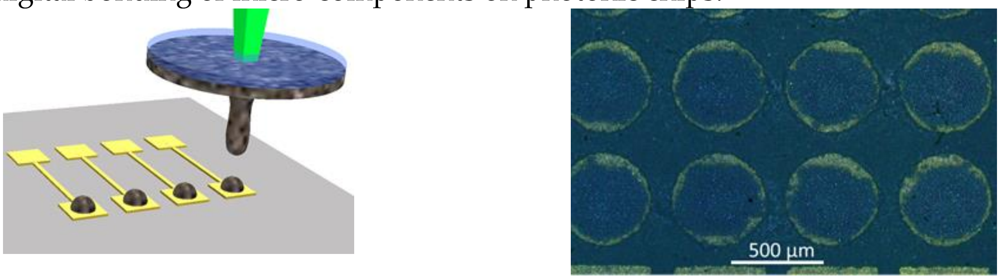
Among different additive manufacturing (AM) technologies, Laser-induced forward transfer (LIFT) has been widely investigated, owing to the eco-friendly rapid processing and the compatibility with a broad range of materials [1]. LIFT has been previously employed for the high throughput printing of Ag NP inks for interconnections [2] and of solder paste for bonding a LED [3]. Here, LIFT has been used (Figure1 (a)) for two applications: the printing of gold patterns onto Si-based substrates and of solder paste patterns.

For the LIFT printing of gold patterns, we explored two types of gold donor substrates—one in solid form consisting of evaporated gold layers with 100 nm, 250 nm, and 450 nm thicknesses on borosilicate glass, and another in liquid form featuring a commercial gold nanoparticle ink with 90 wt% metallic content, coated on glass substrates. Process parameters were investigated (e.g. beam shape, laser fluence) to determine optimum conditions. Preliminary results were promising; printed patterns from the thinnest donor, despite their high surface roughness, showed ohmic behavior in the case of solid phase LIFT, while the surface roughness reduced on the printed patterns in the case of liquid phase LIFT.

For the study of solder paste printing, the laser process conditions were investigated for a commercially available solder paste (particle size 5-15 μm). The donor substrates were prepared by coating the solder paste via an adjustable micrometer film applicator, whose blade height was set at 40 μm, on glass substrates. Finally, circular micro-patterns (Figure 1 (b)) were LIFT printed covering around 90 % of the PCB pad, without exceeding the pad surface. The aim of this work, is to combine LIFT of solder paste and laser soldering process for the digital bonding of micro-components on photonic chips.



(a) (b)

Figure 1: (a) Schematic of the LIFT process, (b) Image of printed solder paste pattern at 1 m/s.

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References: [1] Makrygianni, M., Milionis, A., Kryou, C., Trantakis, I., Poulikakos, D., Zergioti, I., Adv. Mater. Interfaces 2018, 5, 1800440; [2] F. Zacharatos, M. Makrygianni and I. Zergioti, in IEEE Journal of Selected Topics in Quantum Electronics, 27, pp. 1, (2021); [3] M. Makrygianni, F. Zacharatos, K. Andritsos, *et al.*, I. Zergioti, Materials, 14, 3353, (2021).