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Thermo-mechanical modeling of laser-driven non-contact transfer printing

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A thermo-mechanical model is developed to reveal the mechanisms of laser-driven non-contact transfer printing, which is an important emerging variant of transfer printing for materials assembly and micro-/nano-fabrication. The process involves laser-induced impulsive heating to initiate separation at the interface between a soft, elastomeric stamp and hard micro/nanomaterials (i.e. inks) due to a large mismatch of thermal expansion. The inks are then ejected from the stamp to a spatially separated receiving substrate, thereby accomplishing the printing. The temperature field and the energy release rate for interfacial delamination are obtained analytically, and a scaling law is established to identify two non-dimensional combinations of material and geometry parameters that control laser-driven non-contact transfer printing. Finite element method is used to validate the simple scaling law, which is useful to optimal design for transfer printing.

Keywords: Thermo-mechanical modeling, Laser-driven non-contact transfer printing, Heat conduction, Interfacial delamination