COMSOL® Simulation of Blister Actuated Laser Induced Forward Transfer (BA-LIFT)

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Introduction: Laser-induced forward transfer (LIFT) is a non-contact direct-write technique for high-resolution patterns in which a blister drives the flow of the surround fluid, transferring the fluid free of damage [1].

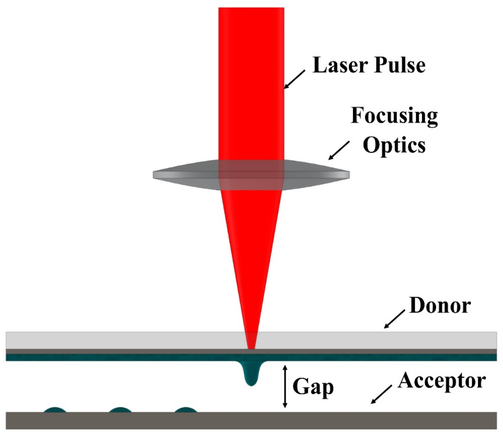

Figure 1. BA-LIFT Process

Computational Methods: The model is implemented as a Two-Phase Flow, Level Set interface, with a moving wall. Its velocity is set through experimental data and a Moving Mesh node. The acceptor is also included to study their influence.

$$\rho\frac{\partial \boldsymbol{u}}{\partial t}+\rho(\boldsymbol{u}\cdot\nabla)\boldsymbol{u}=\nabla\cdot[-p\boldsymbol{I}+\mu(\nabla\boldsymbol{u}+\nabla\boldsymbol{u}^{T})]+\boldsymbol{F}_{g}+\boldsymbol{F}_{st}+\boldsymbol{F}_{ext}+\boldsymbol{F}$$

$$\nabla\cdot\mathbf{u}=0$$

$$\frac{\partial\phi}{\partial t}+\boldsymbol{u}\cdot\nabla\phi=\gamma\nabla\cdot\left(\varepsilon\nabla\phi-\phi(1-\phi)\frac{\nabla\phi}{|\nabla\phi|}\right)$$

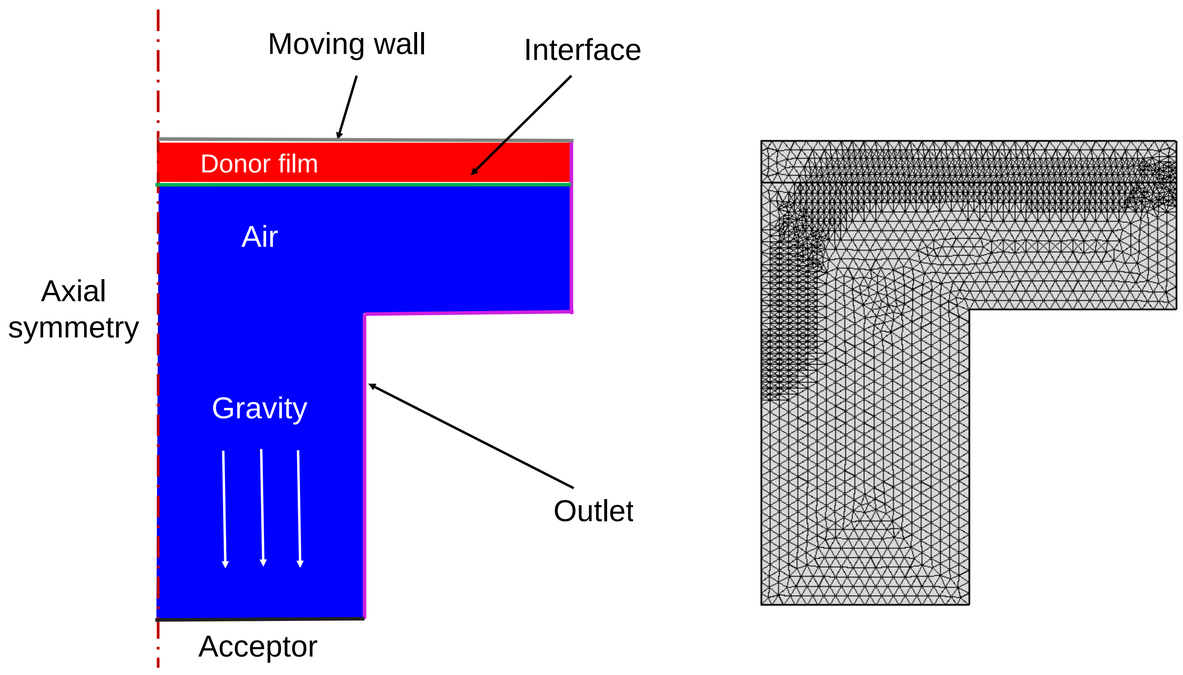

Figure 2. Geometry of the model and adaptive mesh refinement

Results: The validation of the model has been done using the pump-probe imaging technique, the temporal resolution of each frame is given by the pulse duration of the probe source, plasma flash lamps (25 ns) [2].

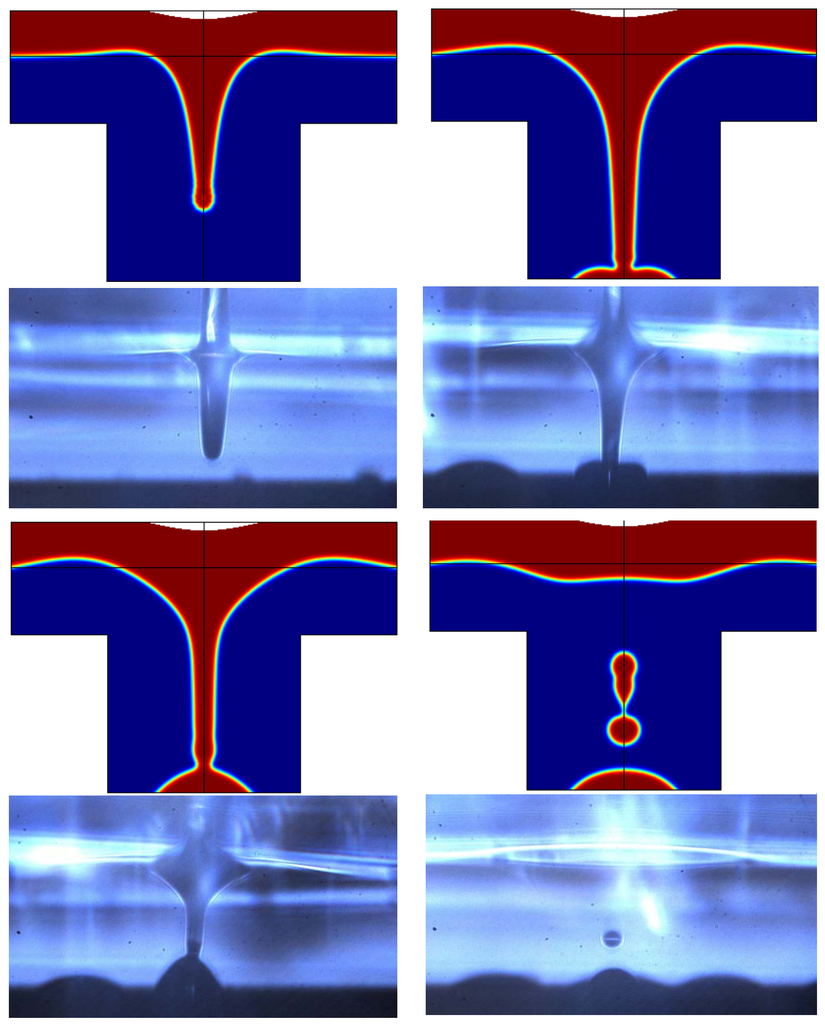

Figure 3. Comparison between simulation and experimental sequence

Conclusions: The printability map of the process is drawn using dimensionless numbers regarding different regimes.

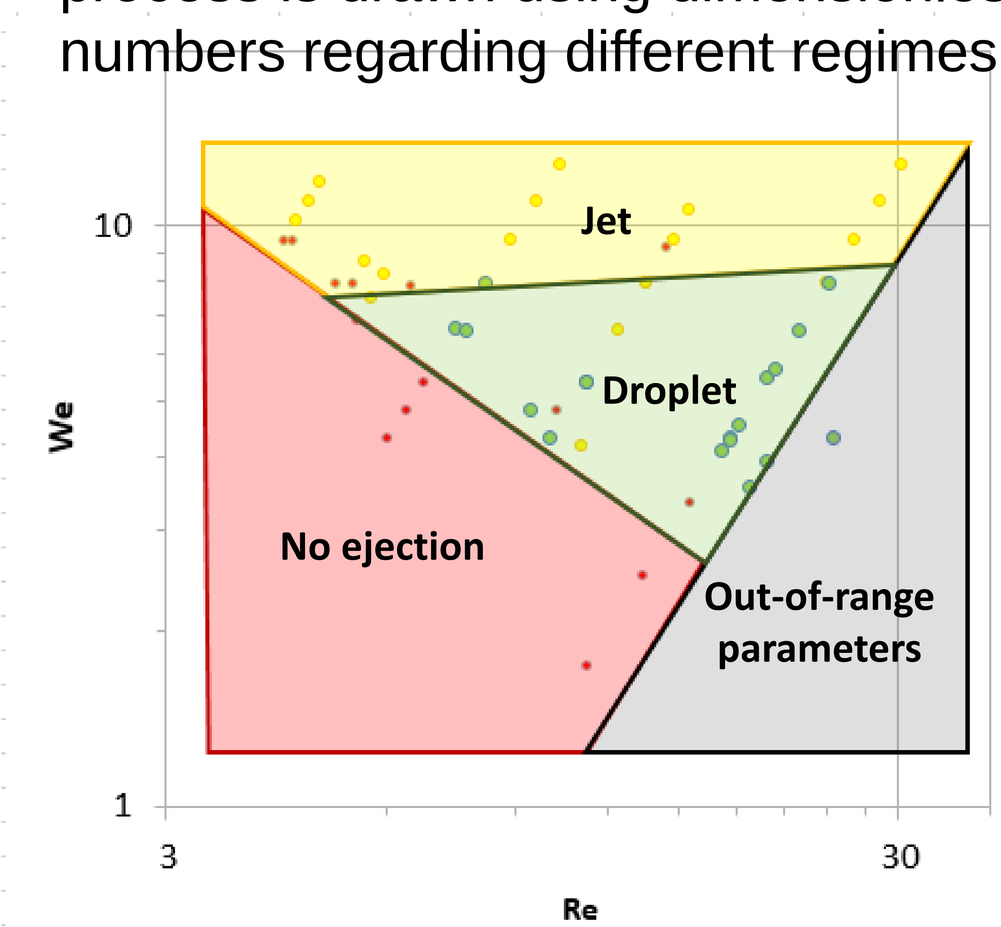

Figure 4. Printability map

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References:

1. M. Morales et al., Laser-Induced Forward Transfer Techniques and Applications in Advances in Laser Materials Processing 2nd Edition, Ed. J. Lawrence, Woodhead Publishing (2017)
2. M.S. Brown et al., Time-resolved study of polyimide absorption layers for blister-actuated laser-induced forward transfer, J. Appl. Phys. 107 (2010) 83103.