Closing the gap: *Fast, reliable adhesive injection with verified mechanics*

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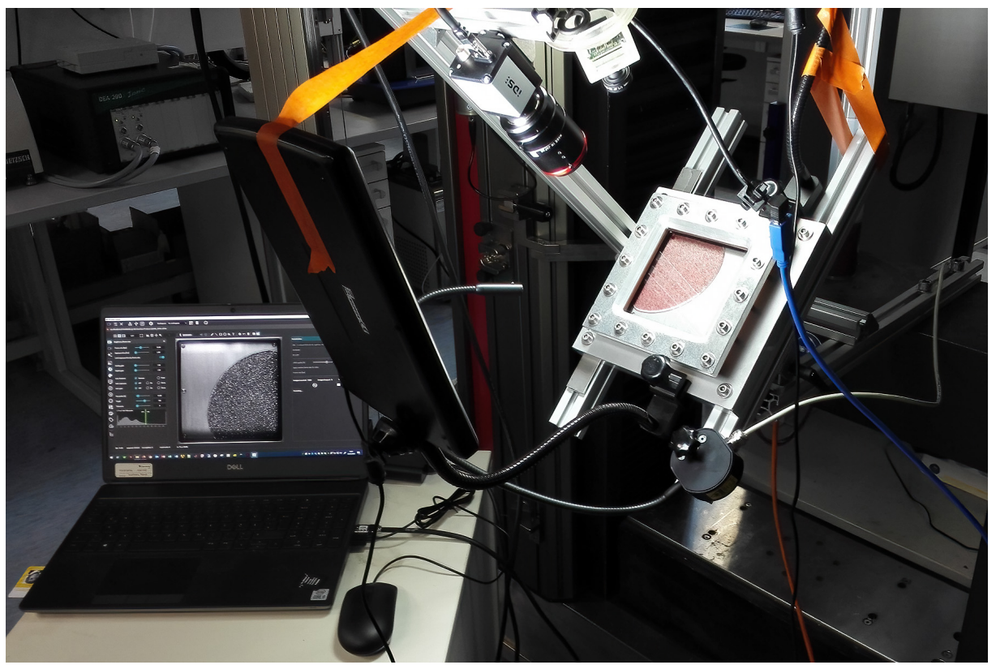
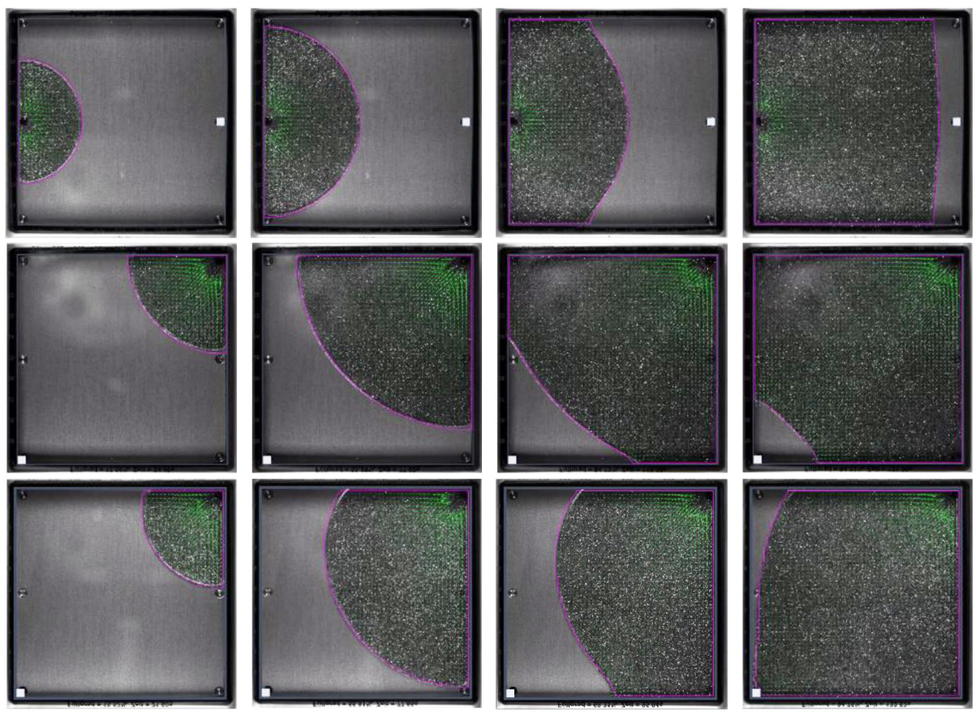
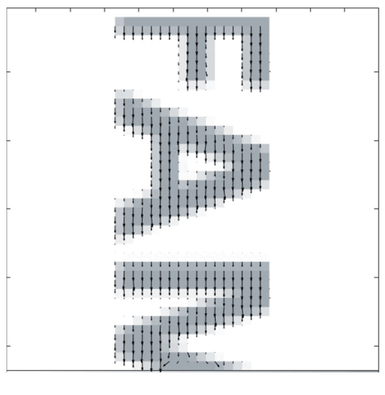
Experimental

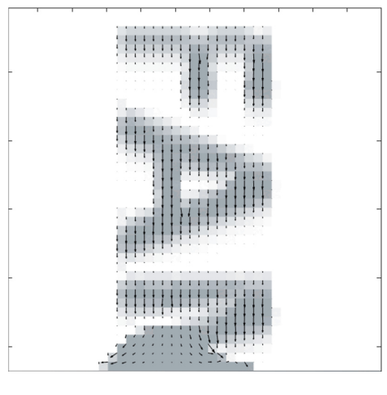
- Quasi-2D glass-plate flow cell (thin bond-line cavity)
- Newtonian surrogate adhesive (silicone oil ~10 Pa·s)
- Controlled injection via displacement-driven piston
- Configurable inlet–outlet layouts (A / B / D)
- Gap height ≈ 2.3 mm (sealed boundaries)
- Inclination cases: 0° / 45° / 90° (gravity effects)

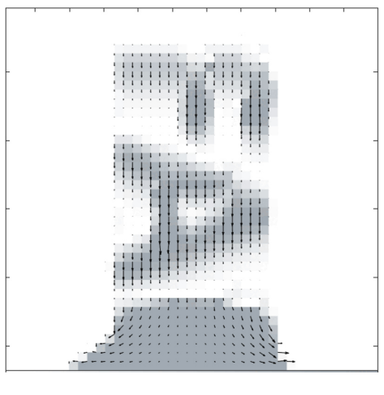


- Flow-front evolution from image sequences
- In-plane velocity fields via PIV
- Injection pressure histories (cartridge + cavity)









Modelling

- Reduced-order gap-flow model (PFGM)
- Depth-averaged thin-film formulation
- Extended from squeeze-flow ⟶ injection-driven filling
- Localised inlets + explicit outlets
- Sealed lateral boundaries implemented
- Gravity included for inclined gaps

Verified for

- *source-flow kinematics*
- *volume conservation*
- *gravity-driven redistribution*

Predicts

- *filling sequence*
- *velocity structure*
- *multi-stage pressure evolution*