Direct Writing of Silicone

Purpose

Determine the capability of silicones in the additive manufacturing process to allow for customizable solutions in the medical, aerospace, automotive, electronic, and consumer industries. Expand the market for Momentive silicones.

Semester Objectives

- Incorporate UV light into the print system and determine the kinetics of curing with the UV light.
- Validate that UV LSR can be used in the direct writing process.
- Test geometrical and mechanical properties of RTV and UV LSR samples.
- Determine write speed and syringe pressure for various sized syringe tips.
- Print RPI keychains using UV LSR.

Material

- Viscosity
  - → Power law relationship
  - → $\eta = m\dot{\gamma}^{n-1}$, n and ma are material constants
- Mass flow rate: $w = \left(\frac{\Delta P R}{2mL}\right)^{1/n}$
  - → Frictional effects neglected in the model

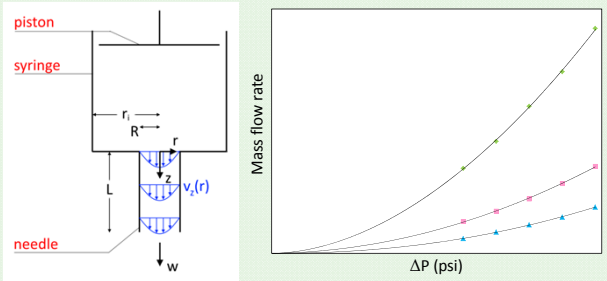

Figure 1: Schematic for the mass flow rate (left) and graph of experimental mass flow rate as a function of pressure for three nozzles (right)

Equipment

- Pneumatic system, limited pressure
- UV light and cable mount
  - → Tack free time tests
  - → Spot cure time tests

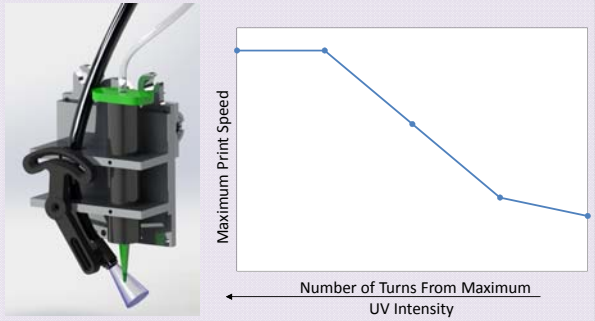

Figure 2: CAD rendering of the syringe and light guide mount (left) and maximum print speed as a function of light intensity for spot curing so that the bead becomes tack free during printing (right)

- Enclosure for 3D printer

Software

- CAD model of part
- Slic3r
- Modification of G code
  - →Bead-to-bead spacing
  - → Z-height

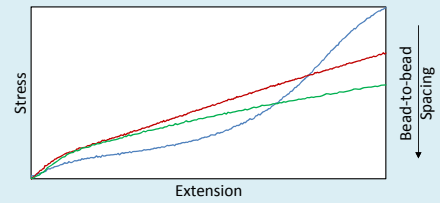

Figure 3: Strength versus normalized extension for bead-to-bead tests (left) and schematic of bead-to-bead test samples (right)

- → Delays and z-lifts to reduce stringing

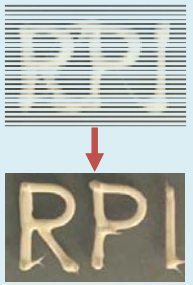

Figure 4: RPI lettering printed in RTV silicone with stringing (top left), without stringing after modification of G code (bottom left), and RPI keychain printed in UV LSR (right)

Recommendations and Future Work

- Implement external control of the UV source
- Use a lower viscosity or shear thinning silicone
- Print with higher resolution and speed
- Implement a second extrusion for support material
- Determine homogeneity of mixed material
- Sell base and catalyst in separate cartridges which mix upon extrusion