

## Abstract

This project aims to construct a valve from a single polymer structure, which replicates the mold surface texture in an effort to reduce cellular adhesion on the valve leaflets. The valve will be created in a mold finished using a magnetic abrasive finishing (MAF) process. As an initial study, blood cell adhesion was quantified by normalizing the number of adhered cells on sample surfaces replicated from finished molds. For the initial trials, silicone was chosen as the valve material. In these preliminary studies, red blood cells were observed to aggregate and adhere to rough surfaces; on smooth surfaces, fewer cells adhered with no aggregation.

## Valve Design

The valve is created as a trileaflet, single polymer structure designed to produce haemodynamic flow similar to a natural heart valve (Figure 1). The valve will be developed in a mold previously finished by MAF in an effort to replicate the mold surface texture on the valve leaflets, shown in Figure 2.

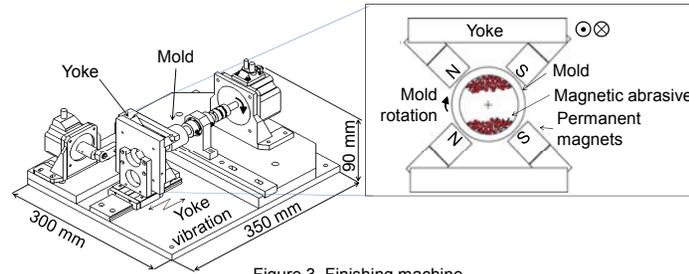


Figure 3. Finishing machine

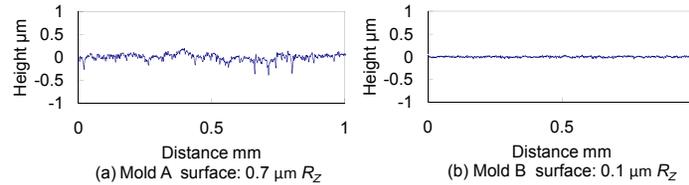


Figure 4. Roughness profiles

## Blood Cell Adhesion Tests

For the initial trials, silicone was chosen as the valve material. To study the effects of surface texture on cellular adhesion, silicone leaflets were developed from finished brass molds and mounted on standard microscope slides, Figure 5 (a). The samples were secured in a polycarbonate flow chamber and flushed with whole human blood followed by phosphate buffered saline, Figures 5 (b) and (c).

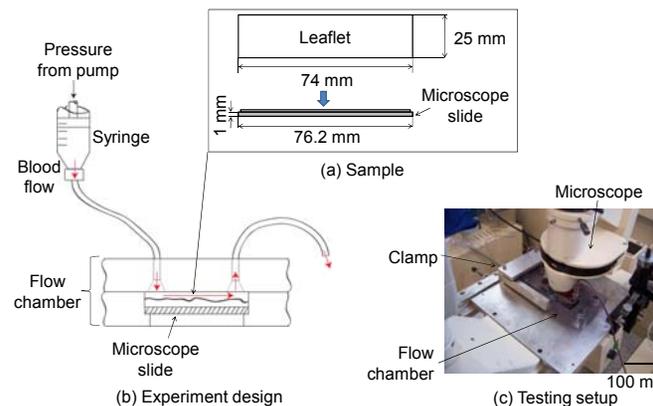


Figure 5. Experimental setup

Whole blood was flushed through the flow chamber at  $50 \text{ mL} \cdot \text{hr}^{-1}$ , at a shear rate of  $220 \text{ s}^{-1}$ . After flushing the leaflet, the leaflet surface was viewed using light microscopy. Blood cell adhesion was quantified by counting the number of adhered cells and normalizing the number to the sample surface area. The experimental conditions are listed in Table 1. Time-lapse images of the sample surface allow differentiation between adhered and flowing cells (Figure 6).

Table 1. Experimental conditions

Solution	Whole blood	Leaflet A	Leaflet B
Volume blood	15 mL		
Passes	1		
Blood flow rate	$50 \text{ mL} \cdot \text{hr}^{-1}$		
Volume saline	15 mL		
Saline flow rate	$50 \text{ mL} \cdot \text{hr}^{-1}$		

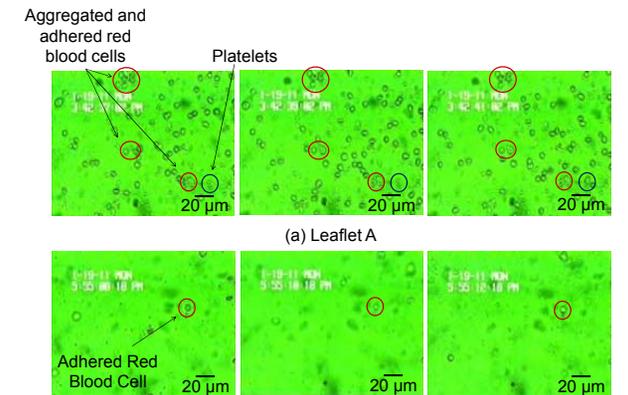


Figure 6. Time-lapsed image

## Conclusion

This study developed a method that uses MAF to fabricate silicone valve leaflets with various surface textures. The corresponding MAF produced silicone surface textures influenced blood cell adhesion and aggregation.

## Acknowledgements

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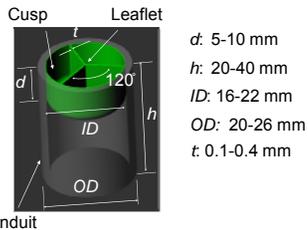


Figure 1. Valve schematic



Figure 2. Medical-grade silicone valve

## Mold Fabrication

A magnetic finishing machine, shown in Figure 3, has been developed to finish the internal surface of the brass molds. In the MAF process, the finished surface is controlled by the relative motion of the magnetic abrasive particles against the workpiece. Relative motion is achieved by rotating the mold and vibrating the finishing unit. The abrasive motion will vary the surface texture of the mold (Figure 4).