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A Simple Flow Cell System for Evaluating the Stability of Non-Fouling Medical Coatings

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TCoE

Abstract:

The surfaces of blood-contacting devices are procoagulant and activate blood into clots during their use. The clots either cause device failure, embolic complications or both. Anti-fouling coatings are therefore applied to the surfaces of these devices to prevent clot formation locally without systemic effects as seen with systemic anticoagulants (See Fig. 1) Unfortunately coated devices still fail from clot formation after about 2 weeks of use. We theorized that the coatings get washed out into flowing blood leading to device failure. The purpose of this study therefore was to develop a flow cell system to test for how long anti-fouling polycarboxybetaine methacrylate (pCBMA) coatings can last under shear stress. To do this, PDMS membranes coated with pCBMA were placed in acrylic flow cells and exposed to variable shear stresses.. Fibrinogen, a key clotting factor, adsorption on PDMS pre and post flows was measured using a standard enzyme-linked immunosorbent assay. Initial results indicate that pCBMA coating on PDMS is stable under the shear stresses tested.

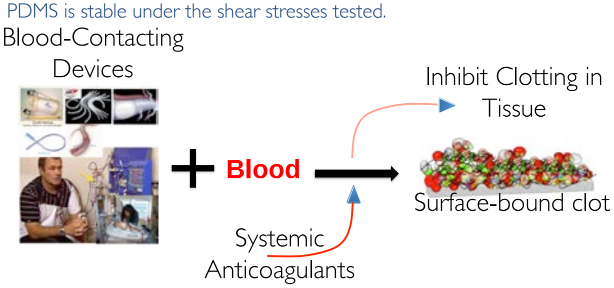

Fig. 1 Limitation of systemic anticoagulants

Materials and Methods:

1. **Flow Cell Design:** Autodesk Inventor.
2. **Flow Cell Fabrication:** Bridgeport miller, drill press etc. (TCoE)
3. **PDMS Membrane Casting:** Two part polymerization reaction.
4. **pCBMA Coating of PDMS:** Graft-to coating in TRIS buffer (pH 8.5)
5. **Flow Circuit:** See Figure 2F.
6. **Coating Stability Testing:** Recirculation (8hrs) of blood substitute (phosphate buffered saline, pH 7.34, ρ=1g/cm^3) over coated PDMS at different shear stresses (1, 6, and 10 dynes/cm^2).
7. **Coating Stability Assessment:** Adsorption of Fibrinogen on uncoated and pCBMA-coated PDMS exposed and unexposed to shear stress.
8. **Materials:** Acrylic, PDMS, Connectors, Tygon tubing, PBS, and Fibrinogen were obtained from Custom Creative Plastics, Sigma Aldrich, Nusil Tech, and Qosina

Results:

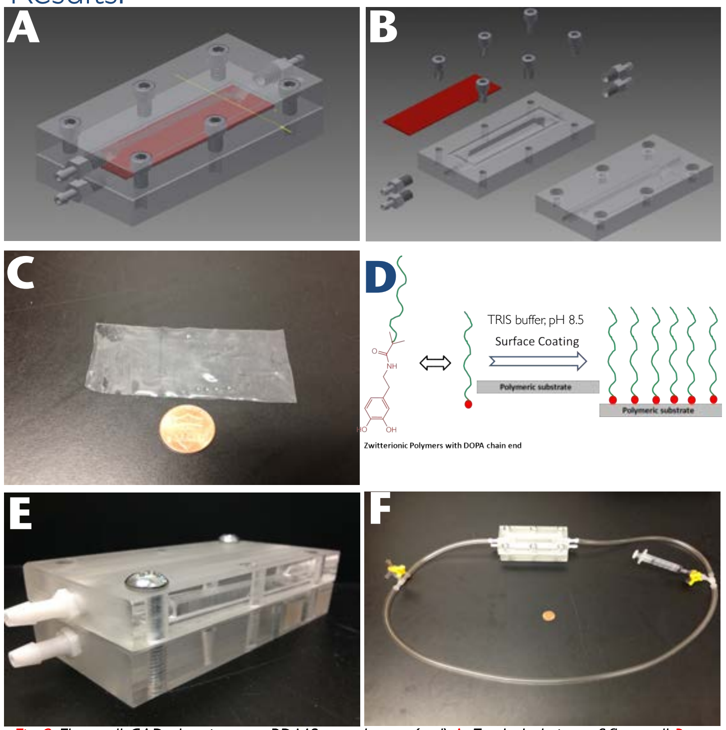

Fig. 2 Flow cell CAD showing test PDMS membrane (red) A, Exploded view of flow cell B, PDMS cast C, pCBMA grafting on PDMS D, Flow cell E, and flow circuit F.

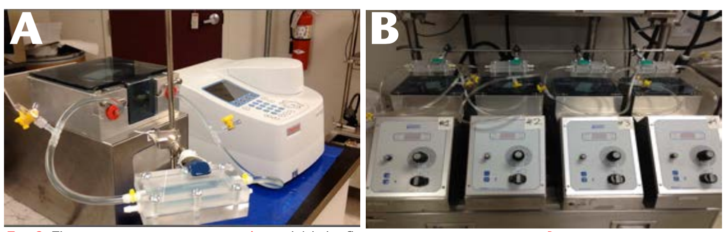

Fig. 3 Flow circuit-pump system A, and Multi flow circuit-pump systems B.

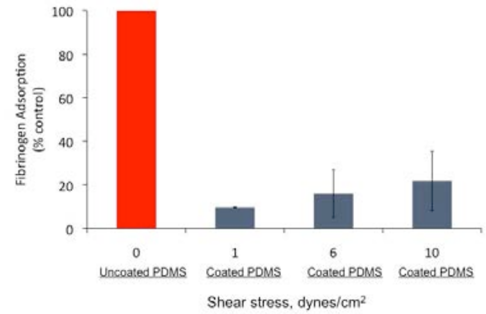

Fig. 4 Fibrinogen adsorption levels on coated PDMS membranes exposed to different shear stresses

Discussion:

The initial results indicate that pCBMA coating on PDMS is stable under the shear stresses tested. Funding to support the collection of additional data is needed to complete this study. Currently the results look promising; pCBMa coating highly reduces fibrinogen adsorption onto PDMS membranes.

Moving forward, we would like to continue experimenting with the coating and for longer flow durations

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