Icing on the Cake: Coating Smart Polymers to Control Cell Interactions

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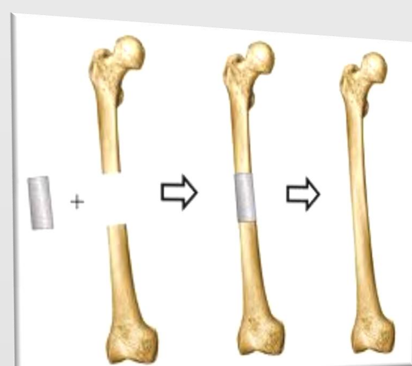
Introduction

Problem: Lack of control over cell substrate interaction for cell culture with shape memory polymers (SMP) only.



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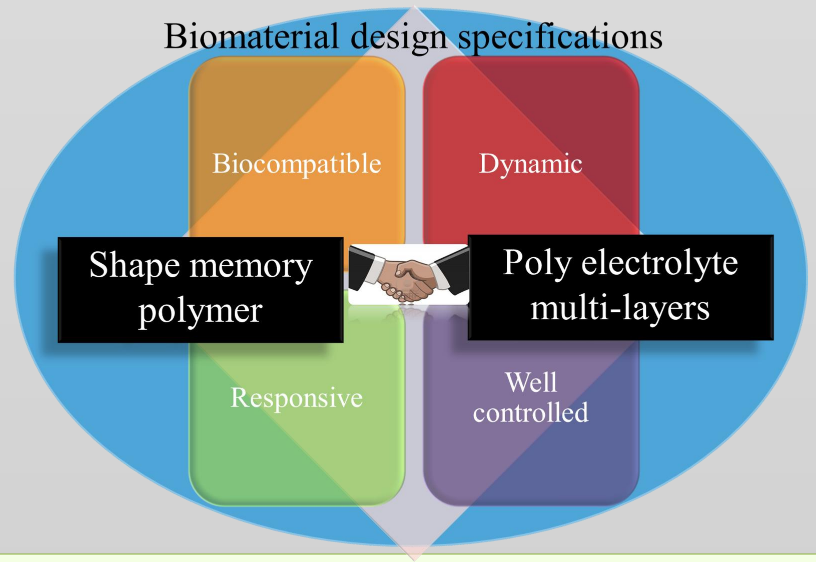
Solution: Combine Polyelectrolyte multi-layers (PEM) with SMP substrate to create new **dynamic, responsive** biomaterial for **improved** wettability and cell surface interactions for tissue engineering applications.

Previous literature has explored the effect of each individual polymer system on cell interactions (Mertz, et. al., 2009; Davis, et. al., 2011). However, SMP and PEM have not been previously combined as a biomaterial in literature. With this innovative biomaterial, we can answer the following questions:

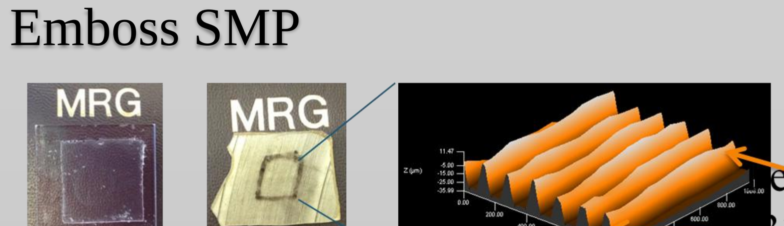
- Can surface composition and topography act synergistically in determining contact angle and cell-materials interactions? Moreover, will surface topography dictate cell fate, proliferation, or differentiation more than surface chemistry?

Biomaterial design specifications



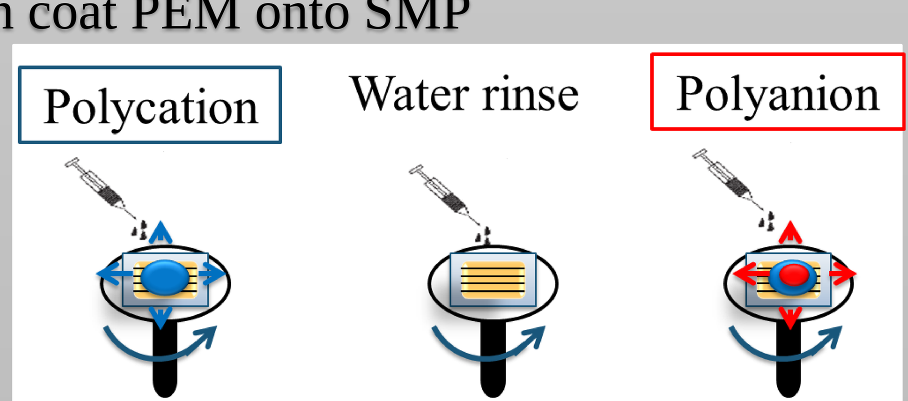
Methods

1) Synthesize SMP
2) Emboss SMP



SMP on glass substrate | Epoxy emboss template | Peak amplitude: 3.98 ±1.42um Peak width: 109.26±9.59 um

3) Prime surface for PEM by creating negative SMP surface charge
4) Spin coat PEM onto SMP



5) Recover to original topography

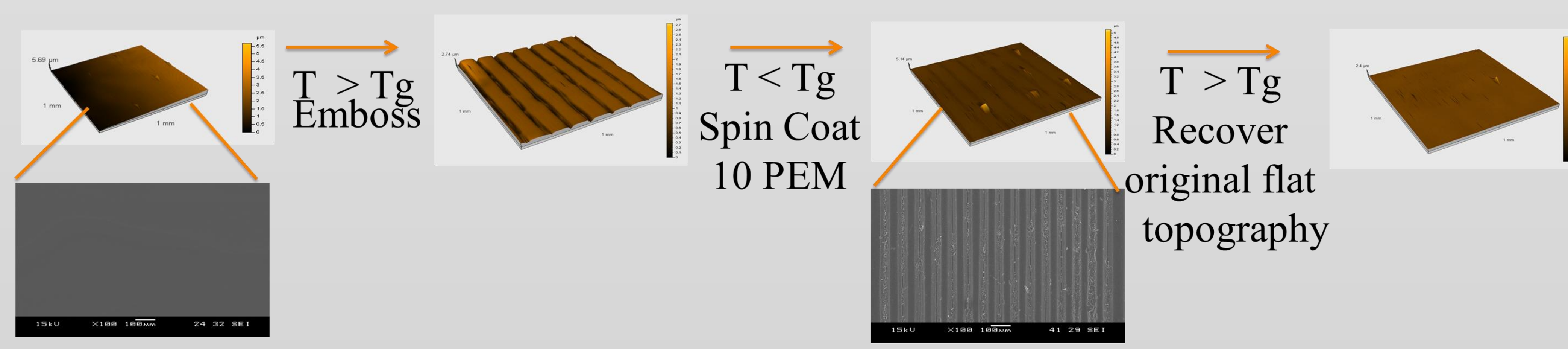
Results

Microstructure analysis

Microstructure changes of the shape memory polymer contribute to the wettability of the substrate. Profilometer and Scanning electron microscopy were used to characterize the microstructure. However, changes in the hydrophobicity also effect cell interface interactions. The synergistic combination of SMP microstructure changes and PEM chemical changes creates a range of contact angles throughout processing of the biomaterial.

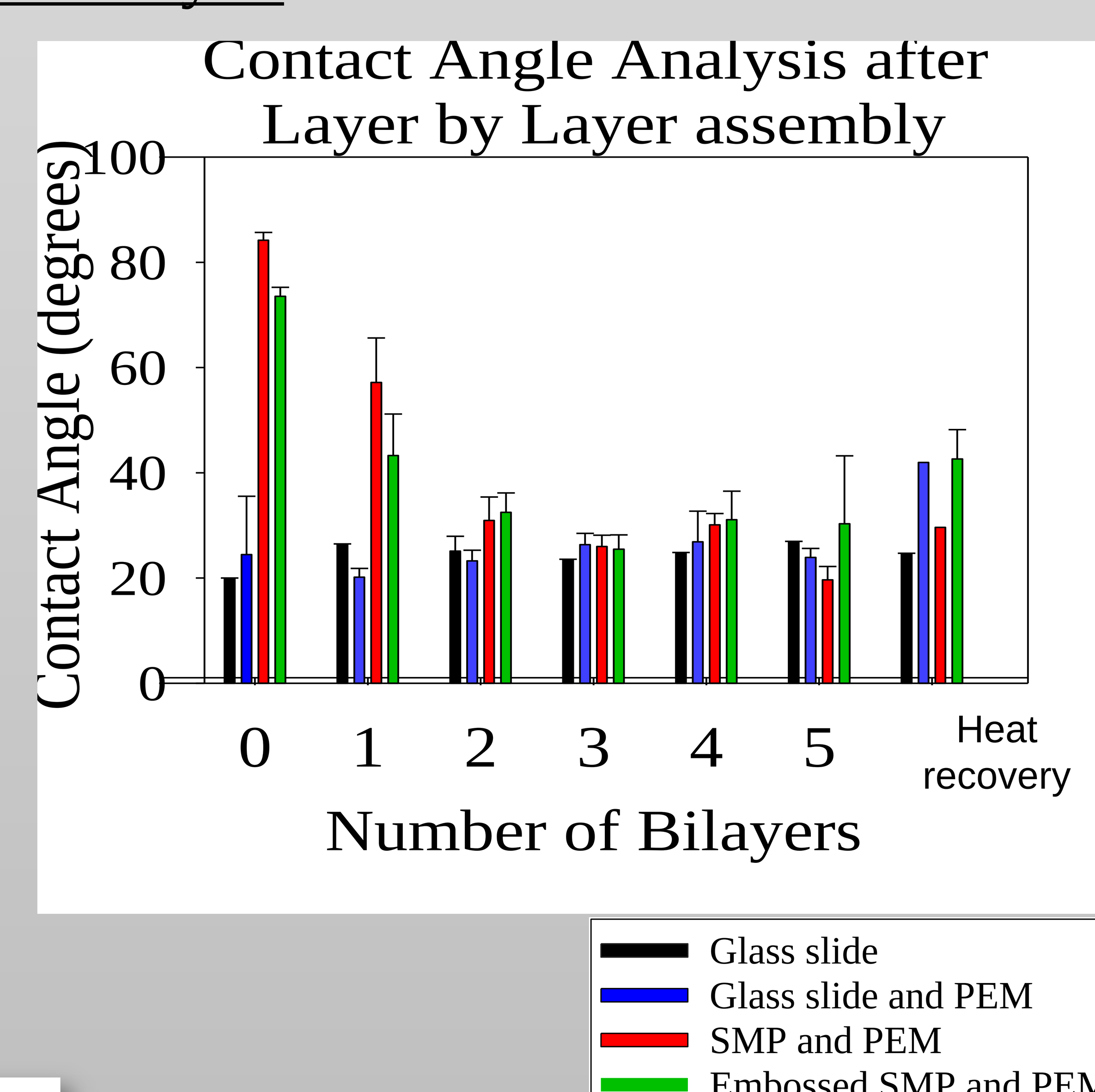
Summary Table of Physical and Chemical Biomaterial changes

Roughness	**Low**	**High**	**Low**	**Intermediate**
Hydrophobicity	**High**	**High**	**Low**	**Low**



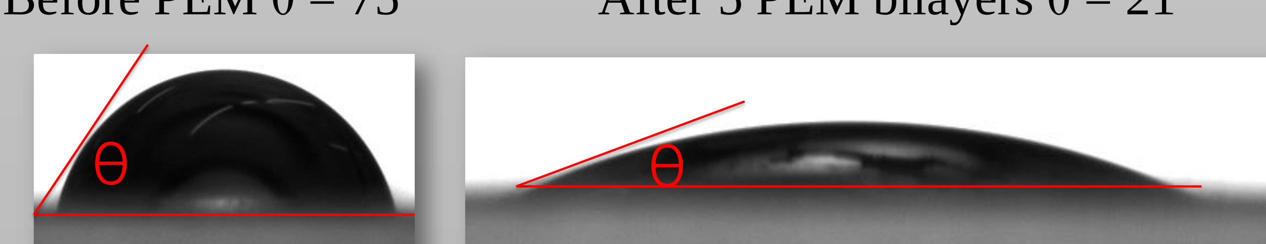
Contact Angle Analysis

Flat and embossed SMP contact angle have a similar trend and reach the same contact angle as glass. The embossed SMP contact angle increases slightly after heat recovery, but does not return to the original flat topography contact angle. This is due to partial recovery of the SMP. Topography recovery may be prevented by PEM. This could also indicate that surface chemistry dictates wettability more than surface topography.



Embossed SMP

Before PEM θ = 75° | After 5 PEM bilayers θ = 21°

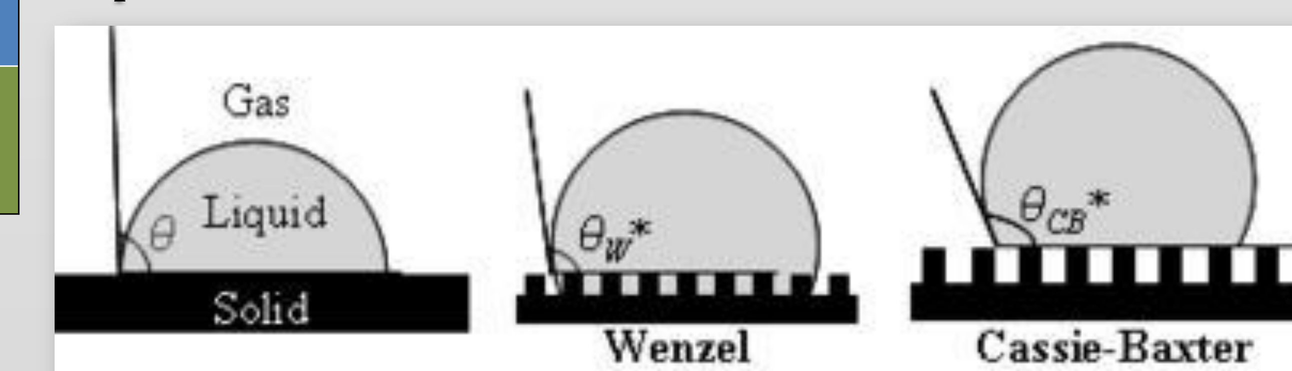


Conclusion

This biomaterial represents a two interface problem of the

- SMP and PEM interface
- PEM and Cell interface

We want to be able to determine the system that dictates contact angle and subsequently cell interactions. In the future, we plan to vary the compressive stress, emboss patterns, and amount of polyelectrolyte multilayers to determine the predominant polymer system for different conditions. With this information, we can optimize the system for cell culture experiments.



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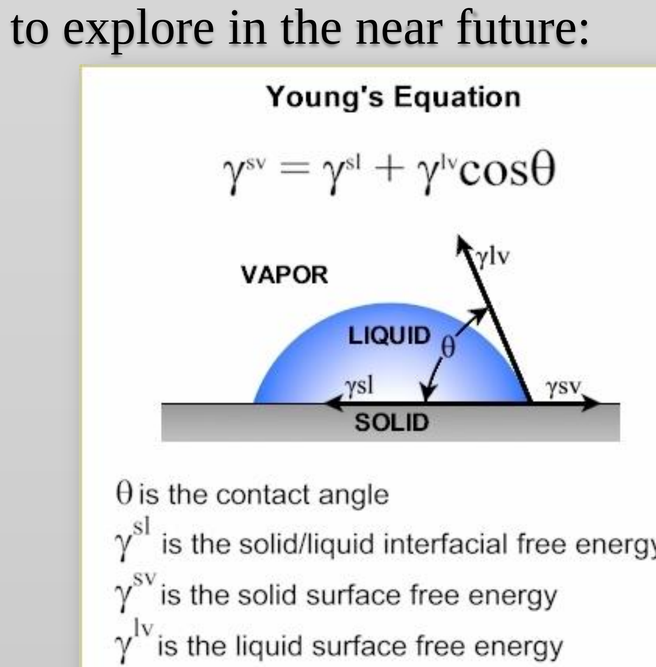
Despite that this project is new and that the combination of SMP and PEM is novel, the results are very promising for creating a new biomaterial with improved cell compatibility for tissue engineering applications. Nonetheless, there are several remaining questions to explore in the near future:

- What is the effect of surface charge and charge density on contact angle?
- Can surface charge or topography create adverse effects on cell motility and proliferation?



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We are eager to answer these questions and explore the endless possibilities of this new combination biomaterial system.

Acknowledgments

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References

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Mertz, D., C. et.al. (2009). "Mechanotransductive surfaces for reversible biocatalysis activation." Nature Materials (8)