

## Ruochong Fei

Final Exam

Doctorate of Philosophy, Biomedical Engineering

SELF-CLEANING MEMBRANES BASED ON  
THERMORESPONSIVE DOUBLE NETWORK HYDROGELS



### Advisory Committee

Dr. Melissa A. Grunlan	Chair
Dr. Gerard L. Coté	Member
Dr. Elizabeth Cosgriff-Hernandez	Member
Dr. Arum Han	Outside Member

ETB 5039, 1:30 pm  
August 28<sup>th</sup>, 2014

## Dissertation for PhD

By providing continuous glucose monitoring, a subcutaneously implanted glucose sensor would greatly improve the quality of life for diabetics. However, implantation of a sensor triggers the host response in which proteins and cells attach and accumulate onto the sensor membrane surface. This membrane biofouling severely limits sensor lifetime and accuracy by restricting glucose diffusion. Whereas attempts to reduce membrane biofouling have mostly relied on passivation approaches, we have designed "self-cleaning" membranes whose surfaces actively detach adhered protein and cells upon thermal cycling. Thermoresponsive poly(*N*-isopropylacrylamide) (PNIPAAm) single network (SN) hydrogels deswell and reswell, respectively, when heated above and cooled below their volume phase transition temperature (*VPTT*). A self-cleaning PNIPAAm membrane would ideally be typically swollen (OFF-state) to facilitate glucose diffusion to the embedded sensor or sensing material. However, when transdermally heated above the *VPTT*, the membrane would reversibly switch to the deswollen state. This cyclical process would cause the active detachment of proteins and cells, thereby cleaning the surface to restore glucose diffusion. Double network (DN) designs, based on assymetically crosslinked, interpenetrating PNIPAAm networks, as well as considerations of membrane geometry and size were utilized to achieve the functional requirements of a self-cleaning membrane.

## Publications

1. **Fei, R.**; Hou, H.; Munoz-Pinto; D.; Han, A.; Hahn, M.S.; Grunlan, M.A. "Thermoresponsive double network micropillared hydrogels for controlled cell release," *accepted to Macromolecular Bioscience*, 2014.
2. **Fei, R.**; George, J.T.; Park, J.; Means, A.K.; Grunlan, M.A. "Ultra-strong thermoresponsive double network hydrogels," *Soft Matter*, 2013, 9, 2912-2919.
3. **Fei, R.**; George, J.T.; Park, J.; Grunlan, M.A. "Thermoresponsive nanocomposite double network hydrogels," *Soft Matter*, 2012, 8, 481-487. *Top 10 Most-Read Soft Matter Articles in Nov. 2011.*

## Awards & Honors

1. College of Engineering Graduate Student Travel Award 02 / 2014
2. Society for Biomaterials Education Challenge 2<sup>nd</sup> Place Honors 04 / 2013
3. Society of Biomaterials Star Award Honorable Mention 03 / 2013
4. Biomaterials Day Travel Grant 07 / 2012

