# Modeling Dynamics of Pattern Formation in Confined Hydrogels

*Yao Xiong [1], Olga Kuksenok [2]

[1]Research Assistant, Department of Materials Science and Engineering, Clemson University， [2]Associate Professor, Department of Materials Science and Engineering, Clemson University

xiong3@clemson.edu

**Keywords:** Gels, Phase transition, Pattern formation, Temperature gradient.

**ABSTRACT**: Understanding and controlling dynamics of pattern development within hydrogel membranes is critical for measuring their mechanical properties, controlling permeability, and fabricating a range of functional surfaces[1]. Pattern formation is often triggered by volume phase transitions (VPT) within hydrogels in response to various external stimuli.[2-5]. The poly(N-isopropylacrylamide) (PNIPAAm) gel is a thermo-responsive hydrogel exhibiting the lower critical solution temperature (LCST) at about 32°C. Herein, we focus on modeling dynamics of pattern formation in confined three-dimensional PNIPAAm gels subjected to temperature gradients by utilizing the three-dimensional gel Lattice Spring Model (gLSM)[6, 7]. We demonstrate that small changes in applied temperature gradients can result in dramatic changes of the observed ordered patterns dependent on the type of confinement. We characterize the dynamics of pattern formation for a range of applied temperature gradients. Our results show that the wavelength of the observed patterns and ordering of these patterns can be controlled by variations in temperature gradients. Thereby, by applying temperature gradients, one can tailor the surface topology of the confined hydrogels and control their permeability.

## References

[1] B. Li, Y. P. Cao, X. Q. Feng, H. J. Gao, *Soft Matter* **2012**, 8, 5728.
[2] T. Tanaka, D. Fillmore, S. T. Sun, I. Nishio, G. Swislow, A. Shah, *Phys. Rev. Lett.* **1980**, 45, 1636.
[3] S. Hirotsu, Y. Hirokawa, T. Tanaka, *J. Chem. Phys.* **1987**, 87, 1392.
[4] A. Suzuki, T. Tanaka, *Nature (London, U. K.)* **1990**, 346, 345.
[5] M. Annaka, K. Motokawa, S. Sasaki, T. Nakahira, H. Kawasaki, H. Maeda, Y. Amo, Y. Tominaga, *J. Chem. Phys.* **2000**, 113, 5980.
[6] V. V. Yashin, O. Kuksenok, A. C. Balazs, *Prog. Polym. Sci.* **2010**, 35, 155.
[7] O. Kuksenok, V. V. Yashin, A. C. Balazs, *Phys. Rev. E* **2008**, 78.