The Summer Undergraduate Research Fellowship (SURF) Symposium
7 August 2014
Purdue University, West Lafayette, Indiana, USA

Investigation of Fracture and Healing Behavior of Thermoreversible Gels via Oscillation Rheology

Krithika Subramaniam, Travis Thornell, and Prof. Kendra Erk
Department of Materials Engineering, Purdue University

ABSTRACT

Thermoreversible gels have the unique ability to self-heal, or repair themselves, once they are fractured. They are physically cross-linked, thus providing them with the capability to reform their broken bonds as a function of temperature. The objective of this project is to determine the extent of the gels' recovery. If self-healing does in fact occur, these gels can be applied in various industries, including medicine for drug delivery or paints and coatings. The tri-block polymer poly(methyl methacrylate)-poly(n-butyl acrylate)-poly(methyl methacrylate) (PMMA-PnBA-PMMA) was heated and stirred with 2-ethyl-1-hexanol to create a polymer gel. Through the use of a rheometer, a shear stress was applied to fracture the bonds. The fixture was then oscillated to gently probe the polymer gel at 28°C, 25°C, 23°C, and 21°C. This data was compared to the unfractured gel to determine the degree of recovery. It was found that the bonds did, indeed, reform, as over 100% recovery was presented in the storage modulus for all four temperatures and in the loss modulus at 23°C and 21°C. However, the plane of fracture is in question. The exact location of the fractured gel hasn't been found, thus to determine exactly how much has been fractured, the applied shear stress time can be extended. Other further experimentation includes using a rheo-PIV (particle image velocimetry) system to properly determine whether the rheometer recorded the fractured or original gel.

KEYWORDS

Rheology, viscosity, thermoreversible gels, rheometer, oscillation, shear stress

REFERENCES

Erk, K.A.; Henderson, K.J.; Shull, K.R. Strain stiffening in synthetic and biopolymer networks. Biomacromolecules 2010, 11, 1358-1363.

Erk, K.A.; Shull, K.R. Rate-dependent stiffening and strain localization in physically associating solutions. Macromolecules 2011, 44, 932-939.

Larson, R. G. (1999). The structure and rheology of complex fluids. New York: Oxford University Press.

Tanaka, F. (2011). Polymer Physics. : Cambridge University Press.