Polymer composites: interphase imaging

Ning Chen[1,4], Chelsea Davis[1], Mitchel Wang[1], Jeremiah Woodcock[1], Mauro Zammarano[2], J. Alexander Liddle[3], Gale Holmes, [1] Ryan Beams[1], Stephan J. Stranick[1], Douglas M. Fox[5], Fritz Vollrath [6], Darshil Shah [6], and Jeffrey W. Gilman[1*]

[1] Material Measurement Laboratory, [2] Engineering Laboratory, [3] Center for Nanoscale Science and Technology, National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, Maryland

[4] Department of Physics, Georgetown University, Washington D.C.

[5] Chemistry Department, American University, Washington D.C.

[6] Department of Zoology, Oxford University, UK

Abstract

Polymer composites are currently used in aerospace, electronics and recreation. New uses are being explored in infrastructure, light-weight vehicles, and in alternative energy applications, such as solar and wind. Arguably the most critical feature of a composite is the interface/interphase. The *interphase* in a polymer composite is the volume of polymer adjacent to the fiber *interface*, and it can comprise up to 30 % of the polymer when nano-scale additives are used. The interphase controls the effectiveness with which the nanoparticle and polymer interact to produce enhanced properties, but it remains a poorly characterized phase. Characterization of polymer dynamics in the interphase is necessary to enable development of next generation composite materials. The development of measurements capable of probing polymer dynamics on length scales, comparable to that of the interphase (1 nm -200 nm), is necessary to enable the development of the fundamental structure property and process-property knowledge. This is especially true for emergent materials such as bio-based polymers composites utilizing silk and nanocellulose fibers. This presentation will highlight recent advancements in applying mechanochromic dyes, hyperspectral imaging and fluorescence life-time microscopy to imaging the interphase in polymer composites.

JEFFREY W. GILMAN, Ph.D.

Dr. JEFFREY W. GILMAN received his B. A. in chemistry from Ithaca College, and his Ph.D. in organic chemistry from the University of California, Irvine from Kenneth Shea. He joined NIST in 1994 as a research polymer chemist. He is currently the leader of the Composites Project at NIST. His recent work focuses on interface imaging using fluorescence methods and cellulose nanofiber composites. He has over 60 peer-reviewed publications, several patents and has authored several book chapters. Dr. Gilman has successfully formed four NIST-Industry research consortia, and has had a number of externally funded research programs during the 22 years at NIST. In 1999 he was awarded the Department of Commerce Bronze Medal, and in 2009 the Jacob Rabinow Award for his nanocomposites work.