



~~~~ Polymer Physics Seminar ~~~~

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301 Steidle Bldg.

Using Raman Microspectroscopy to Image the Polymer Distribution in Composite Materials

Raman microspectroscopy can be used to map the chemical composition of materials with micron-scale resolution, based on the presence of functional groups with Raman-active modes. In this talk, the background and features of Raman spectroscopy and Raman confocal microspectroscopy will be discussed. Examples will be shown of how micro Raman has been used to image patterned layer-by-layer deposited polymers and carbon nanotubes. The spectroscopy combined with imaging allows quantitative confirmation of sample composition that is spatially resolved.

This talk will go into more depth on how Raman microspectroscopy is used to study fuel cell gas diffusion layers. Gas diffusion layers are polymer/carbon composites where a porous carbon mat is impregnated with a fluorinated polymer, such as poly(tetrafluoroethylene), PTFE. The presence of the carbon fibers provides electron conductivity to the fuel cell and the pore space allows for the transport of reactant gas and expulsion of liquid water due to the hydrophobic properties imparted by the presence of PTFE. Measuring the PTFE distribution in the GDL is essential to understanding its gas and liquid transport properties during PEMFC operation. Many studies have correlated the properties and performance of gas diffusion layers with the bulk PTFE loading in the GDL, but there has been little information quantifying the details of the PTFE distribution within the GDL structure. Therefore, new methods are required to spatially resolve the PTFE distribution within the GDL structure.

Raman microspectroscopy is a convenient method in studying the GDL because it is a non-contact and non-destructive method capable of detecting PTFE on the GDL surface. Raman microspectroscopy yields chemical maps derived from point-by-point spectra that resolve features a few microns in dimension, including aggregates of PTFE in the carbon fiber network. The PTFE content and its distribution were measured for a range of GDLs with different bulk PTFE content. The average Raman intensities correlated well with the bulk PTFE content. During sintering of the PTFE, the Raman intensities declined significantly and the features grew larger indicating some spreading of PTFE films in the GDLs. Additionally, the distribution of PTFE was not homogeneous across each side of the GDL indicating that there was a gradient of PTFE through the thickness direction of the GDL. This presentation will detail methods for Raman scanning confocal microscopy and show examples of how the technique can be used to resolve the components in GDL polymer/carbon composites.