Mr. Jerome P. James,***"Determination of Local Porosity Distribustions of Porous Transport Layers of PEMFCs Under Compression Using Micro XCT"*,** 2010 Fuel Cell Seminar & Exposition (FCSE2010), San Antonio, TX. October 17-21, 2010:

This study looks at the feasibility of using micro x-ray computed tomography data of the porous transport layer (PTL) to determine both the in-plane and through plane distributions of local porosity of the layer. The goal is to better understand the anisotropic nature of the material and the porosity by comparing different PTL materials at different levels of compressive strain. It is widely understood that the PTL of proton electrolyte membrane fuel cells (PEMFCs) plays an integral role in the performance of the system. In order to properly understand and optimize the transport phenomena through these porous materials, study of the flow characteristics needs to be undertaken. To achieve this it is necessary to study the micro structure of the material to understand their potential influence on the fluid dynamics. Until recently the main technique in determining surface structure of the PTL has been scanning electron microscopy. This is useful in obtaining surface structural data but fails to show features below the scanned surface unless destructive methods are employed. A relatively new method for obtaining structural data from the PTL involves the use of non-destructive computer tomography. This study uses Xradia's MicroXCT-400 which makes possible 3D visualizations of the PTL on the micro scale with a maximum achievable spatial resolution 700 nanometres. Having a detailed view of the inner layering of the carbon fiber structure opens the field to studies of the inner structural PTL that was not previously possible. Visual analyses of the 3D images obtained show a non-uniform distribution of fibers from a viewing area of approximately 1.3 mm^2. This can be expected to have an impact on the heat and mass transfer properties of the material. Imaging software is used to segment the pores from solid material in each volume image slice to facilitate subsequent analysis. These grey-scale image slices are then converted into a binary image map from which the porosity can be readily calculated using Matlab. Three different types of PTLs (carbon fiber paper, carbon paper backed with a micro porous layer and felt cloth) are compared under a variety of physical criteria including the effect of compressive strain. A novel system was developed to mechanically compress the paper under controlled conditions while it is measured in the X-ray beam. This device acts as a vice compressing the PTL with a controlled pressure. Specifically machined faces reproduce pressure distributions similar to those created by the gas flow channels in actual PEFCs. This gives an insight into the local strain occurring in an actual PEMFC cell. The porosity and fiber distribution results show a high correlation with comparable data sets available in the literature. This suggests that creating a numerical rendering of fiber and pores from tomography data will be a useful tool when designing complex porous media for PEMFCs. Future work will involve mapping the 3D tomography images into a mesh which can be ported into a CFD software package such as OpenFOAM to determine permeability and other transport properties.