Neutron Imaging of Liquid Water Transport in Proton Exchange Membrane Fuel Cells: Heat Transfer and Fluid Dynamics

Water plays a key role in the performance of a proton exchange membrane fuel cell device. However, too much water in the cell can cause “flooding” where the porous layers and gas channels fill up with liquid water which cuts off reactant flow and thus decreases cell output power. Neutron radiography is an extremely promising technique for gaining quantitative information on the water content of the fuel cell. Recent neutron imaging investigations\(^1\) have revealed a strong temperature and current density dependence on the liquid water content of a PEM fuel cell. These results can be explained by considering the local heating of the cell due to the waste heat of the reaction. In addition, small changes in bulk cell temperature can greatly impact the water carrying capacity of the gas, especially at higher temperature due to the exponential increase in water vapor pressure with temperature. This tool will help to further the understanding of liquid water transport in fuel cells and will aid in modeling these complex, coupled phenomena and dynamics. These results will be detailed along with more recent unpublished data that seeks to further elucidate the interplay between liquid water content and waste heat in a PEMFC under various fuel cell operating conditions.