INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Development of Novel Composite Membrane with High Selectivity for Direct Methanol Fuel Cell Applications

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SHORT ABSTRACT

Fossil fuels are the primary sources of power and energy to the mankind even today. Cost-effective and environmentally friendly alternate energy sources alleviate problems associated with fossil fuels. Development of a cost-effective fuel cell along with a high performance has been the objective of several research works. Direct Methanol Fuel Cells (DMFCs) are attractive due to their simple working principle, portability, low operation temperatures, convenient fuel storage and high energy density of methanol. This work involves synthesis of novel nanocomposites for proton exchange membranes for direct methanol fuel cell applications (DMFC) and determination of their selectivity. Initially, general strategies were developed to control the surface functional groups namely carboxyl, carbonyl, epoxy and hydroxyl present on the graphite Oxide (GO) by changing the oxidation temperature from 30 to 110 ºC in modified Hummer's method to determine the best synthesis temperature for modification of membranes. The optimized GO was doped with UiO-66 for fabrication of Sulfonated poly (ether ether ketone) (SPEEK) based polymeric composite membrane. Further it was modified with palladium (Pd) to increase the membrane selectivity for DMFC application. The study encompasses the

effect of amino acid (L-Tyrosine) on selectivity of developed SPEEK membrane. The functional groups and constituent elements were characterized by Fourier Transform Infrared Spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS). The surface morphology was analyzed by Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM). The crystallinity and thermal stability was studied using X-Ray Diffraction (XRD) and Thermogravimetric analysis (TGA) respectively. The physicochemical properties of the SPEEK and SPEEK composite membranes such as ion exchange capacity (IEC), water uptake, methanol permeability, proton conductivity were measured. The results include significant improvement in blocking of methanol upon modification of base polymer using novel composites while on the other hand the membrane conductivity increased significantly. Both these factors result in higher selectivity of the SPEEK composite membrane for DMFC applications, compared to that of benchmark Nafion-117 membrane.