CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

The results of this work show that pure TiO_2 and doped TiO_2 nanoparticles which were prepared using the sol-gel process present anatase phase with mesoporosity. As it can be seen from XRD and Raman results, the structure of doped TiO_2 samples was not significantly changed or distorted from anatase structure of pure TiO_2 and both Nb and Sb dopant were incorporated into the TiO_2 crystal according to EDX analysis. The specific surface areas of doped TiO_2 are higher than that of pure TiO_2 and it is worth pointing out that the doping of antimony affects surface areas more than the doping of niobium in TiO_2, leading to the surface areas of doped TiO_2 enhanced by increasing the amount of Sb dopant. From TEM and SEM/EDX analysis, all of the samples are spherical morphology and both Nb and Sb dopant show good distribution in TiO_2. All of the ceramics were fabricated into thin films and characterized. From TGA results, it can conclude that doped TiO_2 /epoxy films possess good thermal stability and have higher water adsorption ability than TiO_2/epoxy film. Furthermore, the nanocomposite films exhibit good tensile modulus and strength because the ceramic powders show good distribution in the films, corresponding to SEM/EDX micrograph. The proton conductivity values of TiO_2/epoxy membrane was enhanced by doping niobium and antimony into TiO_2 matrix. These imply that these samples have some characteristics to use as a membrane operated at high temperature in proton exchange membrane fuel cell applications.

Recommendations

1. The calcining and sintering condition should be adjusted in order to obtain optimum condition for porosity and morphology of ceramic nanoparticles.
2. The other types of solvent and surfactant in the sol-gel method should be used because they affect to gel time, crystallization of ceramic powders and pore size distribution of ceramic powders.

3. The amount of ceramic powders for preparing membrane should be varied in order to achieve optimum condition for proton conductivity.
4. The ceramic fillers in composites form some agglomeration; therefore the ceramic filler should be modified in order to obtain better distribution of fillers and better proton conductivity.
5. In membrane fabrication, it is difficult to control viscosity of epoxy resin resulting in obtain undesirable thickness of film.
6. The other types of a binder such as PVDF should be used in order to achieve good proton conductivity.
7. The membranes should be treated in acid solution before proton conductivity measurement, which may help to increase proton conductivity of the membranes.
8. The testing of proton conductivity and fuel cell performance should be done at higher temperature in order to achieve good proton conductivity.