

# SYNTHESIS AND CHARACTERISATION OF CONDUCTING POLYMER FILM ON NAFION MEMBRANE

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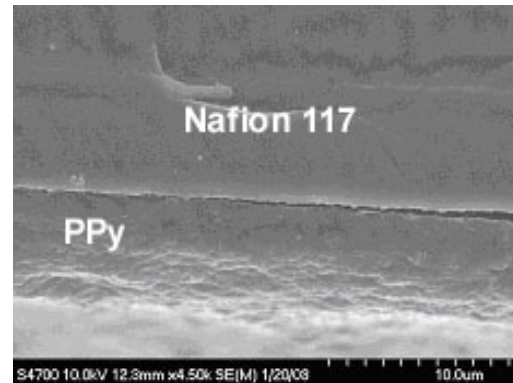
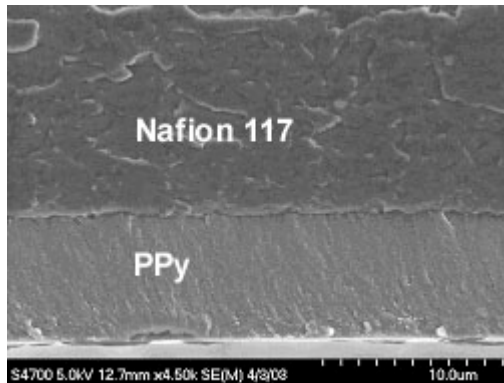
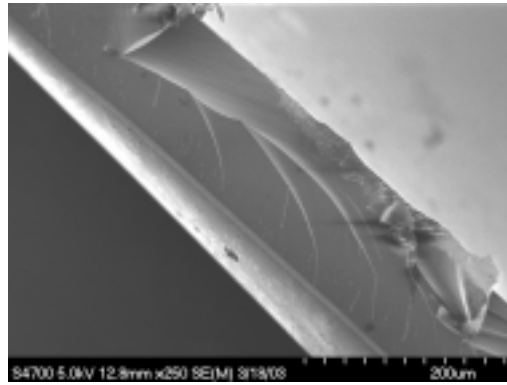
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The development of new materials which can be utilised in membrane electrode assemblies (MEAs) for polymer electrolyte membrane fuel cells (PEMFCs) has received considerable attention during the last decade. In most cases Nafion<sup>®</sup> (DuPont) is used as the polymer electrolyte membrane, which is a cation-exchanger and good proton conductor and exhibits good mechanical and chemical stability. An ideal catalyst support conducts electrons as well as protons, and is permeable to gases and water. This kind of alternative for catalyst support represent between others the conducting polymers (CP), like polypyrrole. These materials are mechanically and chemically stable and easy to prepare. They have a high specific surface area, are porous and permeable to water and gases, while exhibiting both electronic and depending on the preparation conditions ionic conductivity. All these properties lead to an improved three-phase contact between catalyst, catalyst support and ion exchange membrane and an increased catalyst utilization.

One of the methods of CP/Nafion composites preparation proposed in the literature [1] is hot-pressing, which is similar to the conventional manufacturing methods. More appropriate than merging the presynthesised CP films with the PEM seems to be synthesis of the CP directly on the PEM surface. This minimises the risk of composite degradation and lowering the performance of the resulting MEA. Since PEM is not an electronic conductor, direct electrosynthesis of the CP film on its surface is not possible. Therefore chemical polymerisation was used. Here employed preparation method is according to a procedure reported by Hsu [2] who has studied preparation of polyaniline/Nafion composites.

The Nafion membrane was clamped between two reservoirs filled on one side of the membrane with aqueous pyrrole (Py) solution and on the opposite side with the oxidising agent, sodium peroxodisulphate. Py diffuses through the membrane causes polypyrrole (PPy) formation on the Nafion side attached to the solution containing oxidising agent. The polymerisation reaction takes place within few minutes. This is visually indicated by change of membrane colour from colourless to black. Growth of the PPy film was followed in-situ using UV-Vis spectrophotometry. For characterisation of the PPy/Nafion composites electrochemical investigations were carried out. CV curves show an excellent electrochemical activity of the prepared PPy films allowing for potential subsequent electrochemical treatment. In order to investigate the morphology of PPy/Nafion composites SEM measurements were performed. Figure 1 show SEM micrographs of composite which was exposed to the reagent solutions for 1 hour. The lower side of the membrane on the cross-section micrographs was in contact with oxidising agent, the upper side with pyrrole solution. It can be seen clearly that the polypyrrole was formed only onto the surface of the Nafion membrane.

As it was found, the method of PPy film deposition at the Nafion membrane surface proposed in this paper leads to composites of desired properties. Therefore it is suitable for the MEA preparation to be studied in the laboratory PEM fuel cell.



**Fig. 1.** SEM cross-section micrographs of an 1 hour polymerised PPy film on the Nafion membrane surface.

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## References

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2. C.-H. Hsu, *Synthetic Metals* **41-43**, 671 (1991)