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Effects of gamma radiation absorbed dose on VBC grafting onto LDPE films and on anion exchange membrane fuel cells performance

Anion-Exchange Membranes (AEMs) are polymer electrolytes that conduct anions, such as OH- and Cl-, as they contain positively charged [cationic] groups (typically) bound covalently to a polymer backbone. It is possible to take advantage of this characteristic for electrochemical devices, such as fuel cells. Fuel cells are electrochemical systems that convert chemical energy into electrical energy through continuous feeding fuel. These systems represent an alternative technology of electricity with great efficiency and large applicability in the areas of portable, stationary, and automotive powers due to important improvements achieved in the field of electrocatalysis in the past decade. In this present research, AEMs based on films of low density polyethylene (LDPE), were synthesized by radiation induced grafting with 4-vinylbenzylchloride (VBC) monomer solution using direct method. Samples were irradiated with gamma rays from Co-60 at room temperature, in nitrogen and/or air atmosphere at Gammacell of IPEN-CNEN/SP. Several radiation absorbed doses (10-30kGy) were used to study degree of grafting (DoG) of VBC onto LDPE gamma irradiated films. The optimization of parameters and conditions of irradiation have been evaluated by degree of grafting. Functionalization with quaternary ammonium groups was made in water by using trimethylamine (TMA). After, treatment with NaCl for Cl-groups addition was performed, responsible for ionic exchange and ionic groups stabilization. Then, hydroxylation reaction was performed with KOH for hydroxyl groups addition (anionic exchange of Cl- groups by OH-). Besides DoG, characterization of the ion exchange membranes was performed at IPEN-CNEN/SP involving determination of physico-chemical properties such as water uptake, ion exchange capacity and ionic conductivity. Furthermore, AC impedance spectroscopy, scanning electron microscopy (SEM) were performed for characterization of radiation grafted membranes. DoG increased with radiation absorbed dose increase, homopolymerization affected some grafted membranes at high radiation absorbed doses. Also, atmosphere of irradiation affected the DoG. The resulting AEM synthesized by RIG of VBC onto LDPE with 30 kGy radiation absorbed was tested in a fuel cell and reached a maximum power density of 942 mW cm−2 at 80 ℃ with gases flow of 0.8 L min-1 and 0.5 L min-1 for H2 and O2, respectively.

Affiliation

Nuclear and Energy Research Institute, IPEN-CNEN/SP

Country or Int. Organization

Brazil

Primary author: Dr KODAMA, Yasko (Nuclear and Energy Research Institute, IPEN-CNEN/SP)

Co-authors: Dr BIANCOLLI, Ana Laura (Nuclear and Energy Research Institute, IPEN-CNEN/SP); Mr BARBOSA, Andrey (Nuclear and Energy Reseaarch Institute, IPEN-CNEN/SP); Dr SANTIAGO, Elisabete (Nuclear and Energy Research Institute, IPEN-CNEN/SP)

Presenter: Dr KODAMA, Yasko (Nuclear and Energy Research Institute, IPEN-CNEN/SP)

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