An Insight into the Physical Properties of Nafion Langmuir-Schaefer Films

Paolo Bertoncello [a,b, §], Andrea Notargiacomo[c], Paolo Ugo[d], Manoj Kumar Ram[b] and Claudio Nicolini[a,b]

[a] Department of Biophysics, M&O Science and Technologies, University of Genoa, Corso Europa 30, 16132 Genoa, Italy
[b] El.B.A. Foundation, Genoa Section, Corso Europa 30, 16132 Genoa, Italy
[c]Department of Physics "E. Amaldi", Unità I.N.F.M.,Università degli Studi Roma Tre, Via della Vasca Navale 84, 00146 Rome, Italy
[d]Department of Physical Chemistry, University of Venice, S. Marta 2137, 30123, Venice, Italy
§ ECS student active member

Abstract

The surge of interest in perfluorinated ionomers (Nafion) raised long ago due to its thermal stability, mechanical strength, chemical stability, ease in handling, and its chemical and biological inertness. Nafion® finds potential applications in fuel cells, water electrolyzers, chlor-alkali cells, chemically modified electrodes, ion-selective electrodes and sensors. Nafion has been used as a thick membrane or as a film fabricated by solution casting or sol-gel techniques for various such applications. Therefore, it is becoming apparent that the control of the film architecture is needed to fully exploit and understand the Nafion physical properties at molecular level. We report the fabrication of Nafion monolayer at air-water interface, and the deposition of its ultra thin films using the Langmuir-Schaefer (LS) technique. The Langmuir monolayer behaviours of Nafion films at the air-water interface at different aqueous subphases were investigated. The pressure-area isotherms and the Brewster angle microscopic studies are under taken to investigate the characteristics of Langmuir monolayer at different electrolytic media.

The results obtained for Nafion LS films through a combination of physical measurements (UV-vis spectroscopy, atomic force microscopy and nano-gravimetric) indicated a stepwise and uniform growth of films on a substrate. The uniformity of the Nafion LS films was verified by quartz crystal microbalance (QCM). The morphology of different layers of Nafion LS films was studied by atomic force microscopy by using Tapping Mode and contact mode, respectively.

The clustering of Nafion molecules was observed in compact and uniform Nafion LS films. Attempts are also taken to compare the LS films than that obtained by solution cast (Figure 2). The thickness of each LS films was estimated by using AFM study. The ion-exchange and electrochemical behavior of different cations incorporation in Nafion LS films were studied by cyclic voltammetry (CV). The electrochemical behaviour of Nafion LS films were also compared to spin casted films. The diffusion coefficients of solution cast and LS films were estimated using the Randles-Sevcik equation.

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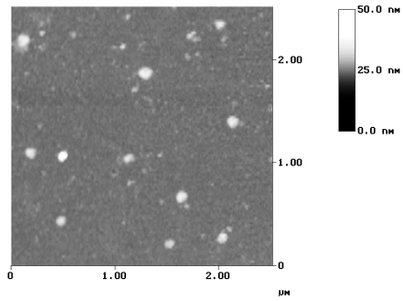

Fig. 1. Typical AFM topography of Nafion LS films

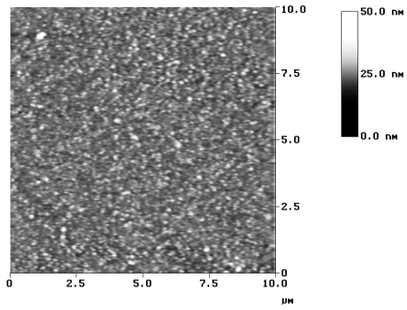

Fig. 2. AFM topography of a Nafion film deposited by spin coater at 750 rpm for 30 sec.