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Muon Studies of the Proton Conducting Polymer Nafion

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The fluorinated ionomer Nafion, first discovered by the DuPont company, is a material that provides efficient proton conducting membranes for application in important technological areas such as hydrogen fuel cells. Although many aspects of the polymer have been studied in relation to these applications, the microscopic mechanisms for proton transport in this polymer are still only poorly understood. We have therefore applied implanted muon techniques to the study of Nafion, aiming to to gain information about these mechanisms via the muon acting as a local spin probe. Our results indicate that the muon is highly sensitive to the hydration state of the polymer and to the dynamical processes of the various sub-phases within the material. A three component model is found to describe the data well. This model has one F-μ-F component reflecting muons in the PTFE-like polymer matrix, a second component representing quasi-static environments that are not closely coupled to the F atoms and a third component encompassing highly dynamic proton-coupled environments. The properties have been studied within this modelling framework as a function of temperature and hydration level.

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