

Poster Summary for Polymer Degradation Discussion Group (PDDG) , Malta, September 1-5, 2019

Study of the influence of fillers and plasticizers on polymer behavior in high-pressure hydrogen environments as applicable to the H2 infrastructure

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Polymeric materials have played a significant role in the adoption of a multi-materials approach towards the development of a safe and cost-effective solution for hydrogen fuel storage in Fuel Cell Vehicles (FCVs). Knowledge gaps exist in areas of damage evolution in polymers due to rapid depressurization rates during explosive decompression phenomena, influence of fillers and additives and their interaction with hydrogen during service and transport properties of hydrogen through polymers leading to permanent and transient hydrogen effects. This study involving the exposure of select elastomeric polymers to high pressure hydrogen (70-100 MPa) under static, isothermal, and isobaric conditions with ex-situ characterization of physical properties such as modulus, density, frictional wear and compression set, has attempted to address some of these gaps. Special attempts have been made to explain hydrogen effects in terms of polymer structure-property relationships in these polymers. Custom polymer formulations of Nitrile Butadiene (NBR) rubber and Ethylene Propylene Diene Monomer (EPDM) rubber with known base polymers, fillers and plasticizers were used in this study with the intention of understanding their interaction with hydrogen. Modern analytical tools such as nanoindentation for hardness changes and micro CT (computed tomography) imaging for capturing internal cracks and voids formation upon rapid depressurization after exposure provide valuable information on the mechanisms for degradation. Selection of optimum characterization methods has enabled the development and documentation of test methods for the testing of polymers in hydrogen environments under the auspices of the Canadian Standards Association (CSA).