# Mechanical durability of anion exchange membranes with humidity cycling

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Proton exchange membrane (PEM) fuel cell development has improved significantly in recent years, however these systems are still restricted by the cost of precious metal catalysts and limited fuel sources. Alkali anion exchange membrane (AEM) fuel cells have the potential to overcome these deficiencies through the use of non-noble catalysts and liquid fuel sources[1]. The basic requirements for an AEM are high ionic conductivity, resistance to fuel/gas crossover, and chemical and mechanical stability over the lifetime of the fuel cell[1]. Systematic study of membrane durability is often overlooked, however mechanical durability is often the ultimate failure mechanism of the membrane in a working cell[2,3]. In a fuel cell, the membrane is exposed to a range of temperatures and humidities during operation and start-up/shut-down. These humidity changes cause swelling in the physically constrained membrane inducing internal stresses. Repeated cycling of humidity can propagate defects and reduce mechanical durability to the point of membrane failure[4].

In this study we have investigated the mechanical and conductive properties of a polystyrene-b-poly(vinylbenzyl trimethylammonium) diblock copolymer system. The mechanical properties of the membranes were studied in both the non-ionic precursor copolymer and after functionalization with cations (Figure 1). Mechanical properties of the membranes significantly decreased after functionalization to the cationic form (Figure 2). The mechanical and conductive properties were also evaluated at different membrane thicknesses. Conductivity increased with reduced membrane thickness, due to the lower resistance of the thin membrane, while mechanical properties decreased.

Continued study of this system will investigate the mechanical properties at a range of steady state humidity conditions and following repetitive humidity cycling. Additionally, the stress induced in the membrane during swelling will be measured by changing humidity in-situ.

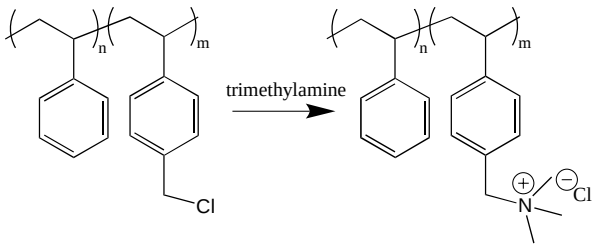


Figure 1: Chemical structure of the diblock precursor, polystyrene-b-poly(vinylbenzyl chloride) (PS-b-PVBC) and the functionalized AEM, polystyrene-b-poly(vinylbenzyl trimethylammonium) (PS-b-[PVBTMA)][Cl]

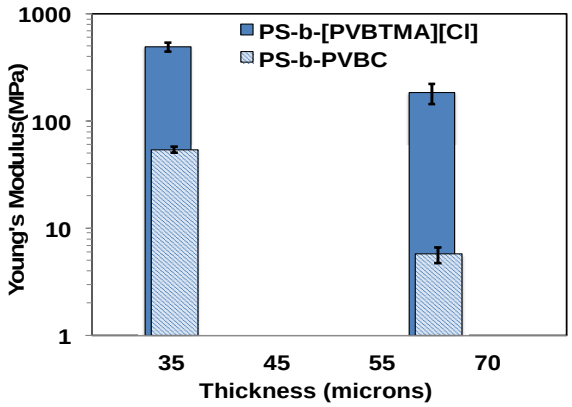


Figure 2: Film elasticity as a function of membrane chemistry and thickness. The Young's Modulus increased following functionalization to the cationic form indicating increased brittleness of the films.

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