Characterization of blend membranes based on block-copolymer/ionic liquids

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The development of selective capture techniques for flue gases such as CO_2, H_2S or SO_2 as well as organic vapours has become an important issue in recent years due to the increasing demand to reduce green house gas emission. One approach being considered is the use of nonvolatile capturing solvents in membrane separation barriers. As a general tendency, membrane separations involving ionic liquids (ILs) are based on the principle of Supported Ionic Liquid Membranes (SILMs). Although the concept is widespread, they reveal several disadvantages amongst which a limited stability under actual operating conditions. We therefore focused on stable, non-porous mixed-matrix-membranes based on the blend of a block co-polymer with different ILs which aims at overcoming the drawbacks SILMs present. Rather than immobilizing the ILs in a porous membrane structure that by itself does not bear any selectivity, we introduced ionic liquids as a plasticizer in dense polymeric membranes during casting. Owing to the high mobility of the ionic liquid phase incorporated, we aimed at improving both membrane selectivity as well as membrane permeability for gas or vapour separations.

The synthesized membranes were investigated with regard to the mechanical stability and permeability to sample vapours and gases. Common thermal characterization techniques such as DSC or TGA were applied in order to observe the stability of the synthesized membranes while FTIR-ATR was employed to elucidate possible interactions taking place within the polymer/IL blend. On the other hand, ^{13}C solid NMR and X-Ray diffraction were used so as to detect how and in what extent the structure of the co-polymer was modified once the IL was incorporated. Gas/vapour sorption tests were conducted with a conventional Cahn electrobalance as well as a non-conventional screening technique based on a quartz crystal microbalance with dissipation monitoring. This latter technique not only provided reproducible sorption measurements when the polymer-IL blend was submitted to either gas or organic vapours, but also similar tendencies (taking into consideration the experimental differences in both techniques) with the benefit of obtaining a rather extremely fast response.

Depending on the ionic liquid selected, we could indeed observe an increase in both selectivity and permeability of the blend membranes. Employing positron annihilation spectroscopy (PALS), we identified respective changes of the free volume of the blend membranes but also revealed an unexpected interaction between the ionic liquids and the block-copolymer. Eventually, the potential of using ionic liquids as selective plasticizers in block-copolymers, or polymers in general, will be critically evaluated.