Robust Olefin/Paraffin Separation Membranes

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Olefins are a key building block of the petrochemicals industry because they are precursor materials for numerous chemical products and plastics. The current commercial production method is steam cracking of ethane followed by cryogenic distillation of olefin/paraffin mixtures, which involves large energy consumption and greenhouse gas footprint. Membranes using facilitated transport show promising olefin/paraffin selectivity due to the presence of carriers that specifically complex with olefins. Unfortunately, facilitated transport-based membranes for olefin/paraffin separation have not been viable because the silver carriers deactivate rapidly in the presence of any H₂, which chemically reduces the silver salts to inactive silver metal. While a number of groups have shown that supported ionic liquid (IL)/silver salt membranes (SILMs) and polymer/silver salt membranes show good olefin/paraffin selectivity, we have discovered that some silver salts and ILs provide protection of the silver salts from reduction by H₂, leading to stable performance over long times. Our work shows that IL/silver salt mixtures in ceramic supports and polymeric/silver salt composites show excellent olefin/paraffin permeability and resistance to reduction by hydrogen. These innovations pave the way for selective olefin/paraffin separation with dramatically reduced energy consumption, that is viable from laboratory to commercial scale operation.