Since the 1960s, ion-exchange membrane separation technologies have been widely applied to numerous industrial fields, including drug, food, energy, chemical industry, biotechnology, waste water treatment, as well as the desalination of sea or brackish water, etc. [1–3]. Undoubtedly, the employed ion-exchange membrane is the most important "hardware" factor deciding whether the separation process is successful or not. According to the chemical structure or the connection of charge groups, ion exchange membranes can be classified into heterogeneous and homogenous membranes, in which the charged groups are physically mixed with or chemically bonded to the membrane matrix (base membrane), respectively [4]. Being different from homogenous membranes, heterogeneous membranes can be produced only by a fairly simple physical hot-processing, in which milling, blending, open milling and thermoforming with two pieces of reinforcing fabrics are usually involved. As a result, the cation or anion exchange resin particles are embedded in the membrane matrix material (e.g., poly(vinyl chloride), polypropylene or polyethylene) to form the so-called heterogeneous structure [5]In this way, these two kinds of inexpensive membrane components and the relatively simple manufacturing process contribute to a very low cost for heterogeneous membranes. This allows heterogeneous membranes to remain competitive in industrial application markets, particularly in the primary electro-driven membrane processes, such as electro-deionization (EDI) and brackish water desalination [6,7]. However, there is an inherent structure drawback for heterogeneous membranes: the hydrophilic ion exchange resin particles are entirely incompatible with the inert membrane matrix material [8]. This inevitably brings the dropout of resin particles from the membrane and the subsequent formation of voids during the whole electro-driven process. Consequently, the membrane's electrical resistance will gradually climb, while the ion permselectivity will accordingly decrease. If this effect cumulates to a large extent, the process will become uneconomic and have to be periodically interrupted to replace new membranes. Due to the short usage life, heterogeneous membranes are not suitable for other high-demand areas (e.g., a strongly acidic or alkaline situation). To overcome this inherent drawback, a great quantity of work focusing on the preparation of several new membrane components (e.g., poly(ether sulfone) (PES) and sulfonated poly(phenylene sulfide) (SPPS) [9],sulfonated poly(ether ketone ketone) (SPEKK) [10] and sulfonated poly(styrene-ethylene/butylene-styrene) (SSEBS) [11]) or physical modification techniques (e.g., the ultrasonic dispersion [10], the addition of inorganic fillers [12] and surface coating [13]) have been made for the purpose of improving the compatibility of heterogeneous cation exchange membranes. However, the above mentioned improvements have the potential of increasing the membrane's manufacturing cost because they mostly adopt the solution casting method, which involves inconvenient preparation processes and adds the extra cost of solvent consumption.

Summarized by © lakhasly.com