DESCRIPTION FOR THE GENERAL PUBLIC

Currently, only a small group of selected polymers was applied as a membrane materials in 90 % of industrial membrane gas separation facilities. Among them are: silicone rubbers, cellulose acetate, polyimides and aromatic polyamides, polysulfones, poly(vinyl chloride) and copolymers of polyacrylonitrile and polyvinylchloride. As a result of intense research, in recent years the findings of separation capability of numerous polymers were published. Many of them exhibit significantly higher permeability and selectivity compared with currently industrially used materials, offering promising opportunities and encouraging development of new, efficient membrane materials for industrial applications.

Gas separation process on dense polymeric membrane is based on solution-diffusion mechanism involving three steps: sorption of the permeants' particles on the high-pressure side of the membrane, permeation by diffusion through the membrane and desorption on the low-pressure side of the membrane (Fig. 1). Separation occurs due to differences in sorption (solubility) and rate of diffusion of gas mixture components in membrane material.

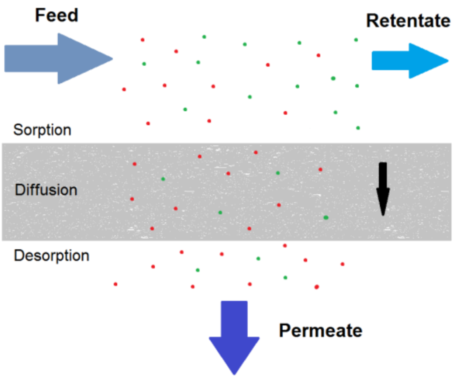

Fig. 1 Gas seperation on dense polymeric membrane (solution-diffusion model)

Air separation on membranes is a challenge, because the small difference in size between oxygen and nitrogen particles (kinetic diameters are 3,46 and 3,64 Å respectively) makes it difficult simply by size effect. O_2, as a smaller molecule diffuses through polymeric materials faster than N_2, but when no specific interactions of one of the gases with material take place, differences in transport rate are not significant. This project is an attempt to find and characterize an attractive, effective material which may be potentially used for oxygen-enriched air production.

There are papers reporting use of conducting polymers, such as polyaniline, polypyrrole and substituted polythiophenes as membranes for gas separation[1]. The most extensive studies in this field were conducted for polyaniline (PANI). Doped PANI membranes exhibit high selectivities in O_2/N_2 separation, which are difficult to explain simply by differences in diffusion rate. It was shown by ESR studies that O_2 forms reversible complexes with PANI due to interaction between O_2 diradical states and polarons[2,3]. That improves solubility of oxygen in polymer matrix without slowing the permeation rate, while solubility of diamagnetic N_2 remains unchanged. If this mechanism is correct, any conjugated polymer doped optimally to give polaron conducting band may be useful in O_2/N_2 separation provided dense membranes can be formed.

Poly(3-alkylthiophenes) (PATs) with adjacent thiophene rings joined in random (nonregular) manner form free-standing, flexible films, which makes them potentially applicable in membrane gas separation, however their selectivity in separation O_2 from N_2 is very low, and permeate enrichment in oxygen is practically insignificant. On the other hand, regioregular PATs are permselective in that system, but brittle and do not form free-standing films. However both types of PATs are miscible to some extent, and obtained blends with a specific composition form membranes which exhibit desired selectivity.

The objective of this project is to farbricate high quality membranes for separation in O_2/N_2 system based on regioregular/nonregular PAT blends. Obtained materials will be p-doped with various dopants on different doping level and then studied for separation parameters, as well as fully characterized by spectroscopic methods. Consequently an optimum dopant and composition of membranes will be found, providing best separation performance of PAT-based membranes.

(1) Pellegrino, J. *Ann. N. Y. Acad. Sci.* **2003**, *984*, 289–305.
(2) Rebattet, L.; Genies, E.; Pineri, J. A. M.; Escoubes, M. *Polym. Adv. Technol.* **1993**, *4*, 32–37.
(3) Mattes, B. R.; Anderson M. R.; Reiss, H; Kaner, R. B. in: Aldissi, M. *Intrinsically Conducting Polymers: An Emerging Technology*; 1993, 61-74.