Preface

(Oxygen/nitrogen) separation from air using a polymer membrane has the wide range of spin-off effects to the gas separation technology. But through an existence polymer membrane, the practical use as the gas separation membrane is limited because there is negative correlation between the (oxygen/nitrogen) permselectivity and the oxygen permeability. The process for the gas separation through the membrane has many advantages such as the simple and compact devices, the easy handling and driving, and facile expansion of scale. Therefore, the material of the membrane is the key of this technology. The requisites for the polymeric gas separation membrane in the next generation are the oxygen permeability with the order of 10^2 Barrer (= 10^{-10} cm^3 (STP) cm/cm^2 s cmHg) and the thin membrane to treat large amount of air and obtain high flux.

As one of the methodologies to concretize such requisites, facilitated transport or carrier-mediated transport is proposed as a process in which a chemically distinct entity (carrier molecule) forms a complex with a specific component, thereby increasing the transport rate of this component relative to other components in the feed stream. We have demonstrated cobalt picketfence porphyrin as an efficient oxygen carrier and applying them to an oxygen-permselective solid membrane. This porphyrin combined with a solid polymer form oxygen-binding specifically and reversibly with high oxygen-binding affinity. However, oxygen transport through this membrane was facilitated only at low feed pressure and oxygen/nitrogen permselectivity was limited to ca. 10. To develop this knowledge as oxygen facilitated membrane with bearing the criteria of university, there remained three issues to be studied. (i) Oxygen carrier with high reactivity. (ii) Increase the carrier content in the membrane. (iii) Casting a defect-free thin membrane with simple method.

In this thesis, simple and planar cobalt porphyrins without any cavity structure were selected as an oxygen carrier. These porphyrins have a compact structure, thus high oxygen reactivity and enlarge the amount of carrier in the solid membrane were expected. The cobaltporphyrin polymer complex membranes with nanometer thickness were successfully prepared and reversible oxygen-binding to the membranes was observed spectroscopically. High oxygen permselectivity with high flux that are fare more than the existing result were obtained in good accordance with a concentration fluctuation model.

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