Descriptions of Research Topics

- Synthesis of nanoporous membrane with molecular network
- Development of nanostructured organic/inorganic hybrid materials
- Development of catalytic membrane reactor
- Fundamental study on the chemistry with a membrane platform

Applications:
- Ultrafiltration and nanofiltration
- Gas separation & gas capture
- Catalytic membrane reactor

Development and application of a new bottom-up membrane synthesis methods from molecular networks
1. Development of a new membrane synthesis strategy

- **Bottom-up membrane synthesis from molecular network**
  - Molecular layer deposition
  - Processing of nanostructured molecular network into a practical module format (flat sheet, spiral wound, hollow fiber)

- **Development of various types of membrane from molecular network**
  - Thin film composite membrane
  - Homogeneous nanoporous membrane
    - One-pot membrane formation by filtration
    - Controllable membrane thickness
    - Solution-processability
    - Functional mesopore surface

- **Membrane module formulation**
  - Hollow fiber format
  - Spiral wound format

- **Synthesis of nanoporous membrane for specific applications**
- **Solution processing of molecular network toward a practical module development**
2. Ultrafiltration and nanofiltration membrane

- **Key issues in membrane-based ultrafiltration and nanofiltration**
  - **Ultrafiltration**: filtration of colloidal particles and macromolecules such as proteins
  - **Nanofiltration**: retention of molecules (200~300 Da), divalent and higher valent ions

- **Strategies to tackle the key issues in ultrafiltration and nanofiltration**
  - < In situ hydrophilic grafting >
  - < Biomimetic membrane by MLD >

- **Permeability trade-off**
  - High flux, high selectivity

- **Molecular separation**
  - Precise pore size tuning

- **Anti-fouling properties**
  - Reduction of adsorption

- **Organic solvent resistance**
  - Long-term stability

- **Application**
  - **Nanoparticle separation**
  - **Bio-separation**
    - Protein, DNA separation
  - **Organic solvent nanofiltration**
    - Pharmaceuticals, peptide
    - Fine chemical separation

- Robust ultrafiltration membrane with diverse surface functionalities
- Molecular layer deposition approach for biomimetic nanofiltration membrane

- ✔ Facile method for robust membrane synthesis
- ✔ Hydrophilic coating for high water flux
- ✔ Aquaporin-mimetic artificial nanochannel
- ✔ Precise control in pore size and thickness through molecular layer deposition

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3. Gas separation membrane

- **Microporous polymer composite membrane for CO\textsubscript{2} separation**
  - Overcoming permeability-selectivity trade-off is a critical issue.
  - **How to control gas affinity and diffusion?**
  - Various membrane catalyst system (enzyme, nanoparticle, organic catalyst)
  - Enhanced stability, recyclability
  - Application to batch and flow reaction

- Composite membrane of commercial polymer and CO\textsubscript{2}-philic rigid molecular network for high performance CO\textsubscript{2} separation

4. Catalytic membrane reactor

- **Continuous nanopores in membrane for catalytic reaction**
  - Various membrane catalyst system (enzyme, nanoparticle, organic catalyst)
  - Enhanced stability, recyclability
  - Application to batch and flow reaction

- Compact catalytic membrane reactor for efficient enzymatic and chemical reaction
- Development of a membrane-based reactor system