University of Fribourg / Faculty of Science and Medicine / Department of Chemistry

# Functional Porous Materials and Membranes for Gas Capture and Separation Applications

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Increased $CO_2$ emissions into the atmosphere primarily originating from the consumption fossil fuels has caused global warming and other related environmental issues, thus necessitating an urgent development of materials that can be used for separation and capture of $CO_2$.
This thesis has focused on two aspects of this problem; that are the separation of $CO_2$ and its selective capture from various emission sources.
At first, novel two-dimensional materials such as graphene have been developed as two-dimensional membranes for $CO_2$ separation. In the first approach, porous graphene was coated with various metal layers to act as an adsorptive layer to capture a single gas in a binary gas mixture. In the second approach, inert gold layer was used to control pore size on the graphene surface in order to achieve pores below 3 nm to facilitate molecular sieving. Moreover, gas transport mechanism in relation with the pore size was also studied in detail. In the third approach, stimuli-responsive membranes were investigated for switchable gas separation. Series of membranes with varying amounts of polymeric carbon nitride were prepared and light switchable gas transport was studied in detail.
Secondly, porous organic polymers (POP) have been studied to selectively capture $CO_2$ under various conditions. In the first approach, effect of the macrocycle on the $CO_2$ affinity of POP was studied. To do so, cyclotetrabenzoin octaketone with its unique square-shaped pore was chosen to prepare three-dimensional POP with 5.8 Å pores. In the second approach, table salt, NaCl was used as a hard template to control the porosity of POPs synthesized under solvothermal conditions. The introduction of NaCl template allowed not only to enhance textural properties, but also made it possible to control the ratio of micropores and mesopores. The resulting POPs were used for multiple applications such as $CO_2$ capture and radioiodine uptake. Moreover, by changing the template it is also possible to control the pore size and target specific application.

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