DEVELOPMENT OF A NOVEL Pd-BASED HETEROGENEOUS CATALYST FOR CO₂ CONVERSION

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Various efforts have been attempted to mitigate global warming by reducing the CO₂ emission

Objective
Developing a novel Pd-based heterogeneous catalyst to enhance the catalytic conversion of CO₂ by H₂ for the synthesis of value-added chemicals such as CO, methanol and fuels

Background
The elevated CO₂ emissions contribute to the increase of the greenhouse effect

Objective
Hydrogen is a high energy material which can be used as the reagent for CO₂ transformation

Results
- The Pd solution was tuned to be either acidic or basic to adapt to different catalyst support
- The heterogeneous catalyst was synthesized on alumina support (acidic) and active carbon support (basic)

- The solution was characterized by ultraviolet-visible spectroscopy at the wavelength of 190 - 1000 nm

Two absorption peaks were observed indicating the existence of two Pd species in the solution

Future Studies
1. Test the performance of the synthesized catalysts using a continuous fixed-bed reactor
2. Collaborate with Brookhaven National Lab (BNL) and Dalian Institute of Chemical Physics (DICP) on catalyst characterizations: Brunauer Emmett Teller (BET) surface area, pore size and volume, Transmission Electron Microscope (TEM), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD)
3. Establish a relationship between activity and properties
4. Understand the reaction pathway for CO₂ hydrogenation

Challenge
Since CO₂ hydrogenation does not always produce methanol and fuels, we need to develop an efficient catalyst and minimize the formation of by-products

Chemical Reactions
- CO₂ + H₂ → CO + H₂O \( \Delta H_{\text{f}}(298K) = 38 \text{ kJ/mol} \)
- CO + 2H₂ → (CH₂)₂ + H₂O \( \Delta H_{\text{f}}(298K) = -166 \text{ kJ/mol} \)

- CO₂ + H₂® Chemicals
- Methanol
- Fuels® Hydrocarbons
- Zeolite® HC Fuels

A. Preparation of Pd(II) complex solution

ACIDIC System
- 0.0107 g of Oxalic acid was added to 5 g of acetone
- 0.0858 g of Palladium acetate is added to the solution
- 0.097 g of Tinoxalate and 0.134 g of Ammoniumoxalate is added to 10 ml of DI-water
- The Tin solution is added to the Pd one

B. Wet Incipient Impregnation
- Add the solution to 5 g of support until the support is damp
- Dry the support in a rotating tumbler with drying lamp
- When the support has absorbed all the solution, dry in the oven at 120°C overnight

References