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Innovative Silver-Based Catalyst for Oxidation of Methane to Methanol

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BACKGROUND:

- **Methane is a main component of many natural gas reserves**
- **It is fundamental for an effective method to be developed for inexpensive and abundant methane to be converted to value added chemicals:**
  - Methanol
  - Formaldehyde
  - Acetic acid
  - Carbon monoxide
  - Fuel

Previously Published Research Methods for Conversion of Methane to Methanol

Conventional Production of Methanol from Syngas Process (Multistep)

- **Disadvantage**: Costly due to high-energy consumption

Direct Methane Partial Direct Oxidation to Methanol Routes

- **Disadvantages:**
  - Reaction is thermodynamically spontaneous at room temperature
  - Difficult to control the selectivity of products
    - Methanol is more reactive than methane

Led to research for the development of a highly selective catalyst

OBJECTIVE:

The development of an innovative silver-based catalyst will be created as an alternative, more effective method for the conversion of methane to methanol

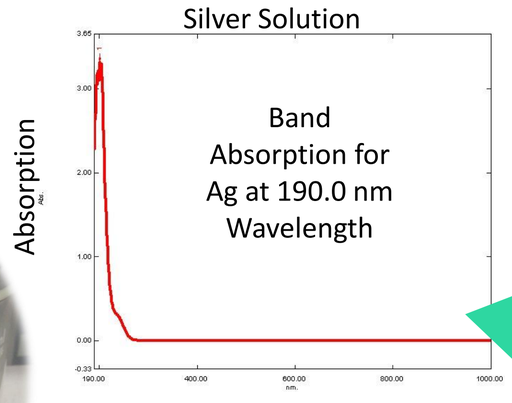
METHOD:

Solution Chemistry to Prepare Ag-Based Solution

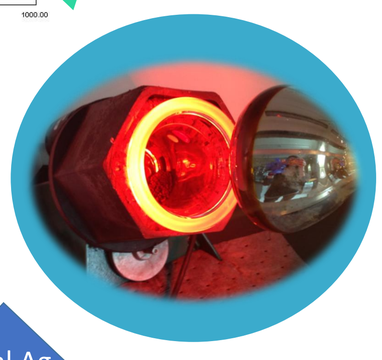
0.416 g Ethylenediamine Added to 2.5 g Di-Water with Stirring

0.283 g Oxalic Acid Added with Stirring

Ultraviolet-Visible Spectroscopy of Silver Solution



Wet Incipient Impregnation of Ag Solution on Carbon Support (Basic)



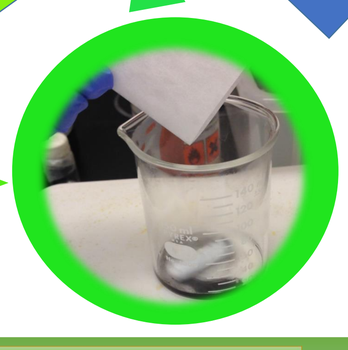
Observed Color Change Black to Clear Immediately

pH = 10.67

Final Ag-Based Catalyst

0.107 g Silver Oxide

Added To



Thermodynamic Analysis of Reactions:

$$CH_4 + \frac{1}{2}O_2 = CH_3OH \qquad \Delta H^0\ (298K) = -126\ kJ\ mol^{-1} \qquad (1)$$

$$CH_4 + \frac{3}{2}O_2 = CO + 2H_2O \qquad \Delta H^0\ (298K) = -519\ kJ\ mol^{-1} \qquad (2)$$

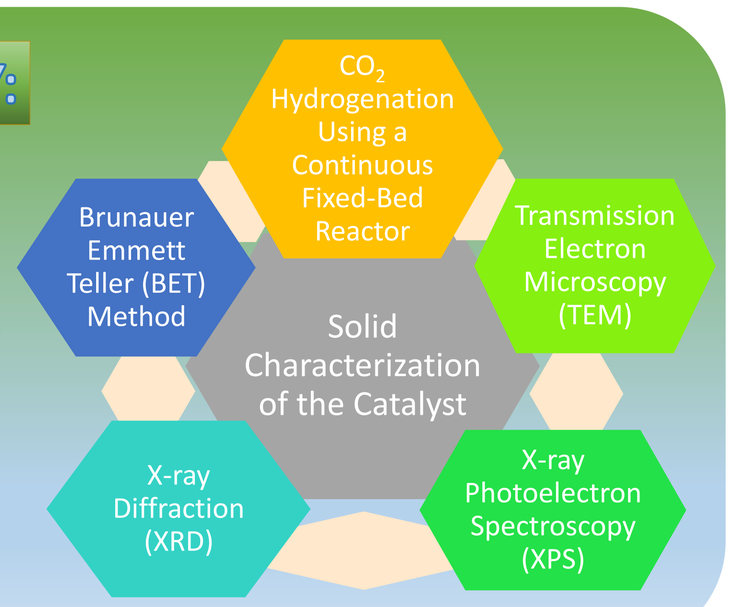
$$CH_4 + 2O_2 = CO_2 + 2H_2O \qquad \Delta H^0\ (298K) = -901\ kJ\ mol^{-1} \qquad (3)$$

$$CH_3OH + \frac{3}{2}O_2 = CO_2 + 2H_2O \qquad \Delta H^0\ (298K) = -775\ kJ\ mol^{-1} \qquad (4)$$

FUTURE STUDY:

Collaboration with Brookhaven National Laboratory and the Dalian Institute of Chemical Physics in China

- ❑ Establish Relationship Between Activity and Properties
- ❑ Test Performance of Silver-Based Catalyst for Oxidation of Methane to Methanol
- ❑ Understand Reaction Pathway of Methane to Methanol



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