Characterization of Alumina Supported Syn-Gas Conversion Bimetallic Nanocatalysts

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Abstract

The purpose of this project is to increase the efficiency of the Fischer-Tropsch process by targeting the most effective catalyst for the reaction. In previous work, different compositions of nanoparticle metal oxides (Co, Fe, and Cu) co-entrapped sol-gels were synthesized, reduced, and ran catalytic reaction. The products were analyzed using a gas chromatography system (GC). The samples were analyzed after synthesis, reduction, and catalytic reaction using a Vibrating Sample Magnetometer (VSM) for their magnetic properties and the Differential Thermal Analysis (DTA) and Thermal Gravimetric Analysis (TGA) for their thermal properties. Our goal was to analyze the samples after each process to determine a trend in our results that could possibly lead to a reasonable conclusion. The main objective of this project is to study the order of ferromagnetism for each of the samples. By analyzing the saturation magnetization of these samples, we will be able to provide estimations on metal loading, reduction efficiency, and poisoning of the catalyst.

Synthesis Sol- Gel Shaped Nanoparticle Catalysts

Precursor Sol

Aluminum tri-sec-butoxide

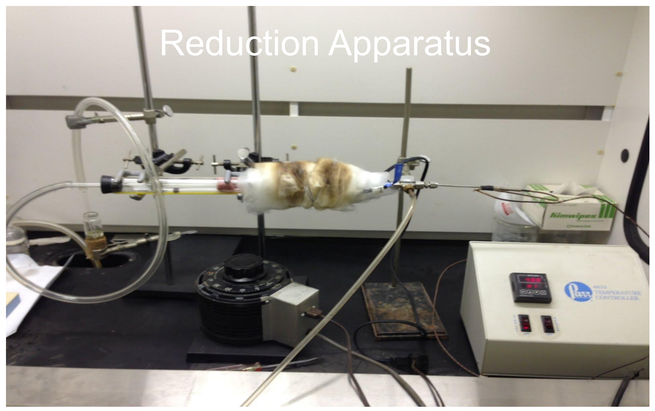
Sol-gel and gel shaping

$Ni(NO_3)_2$,$Co(NO_3)_2$, Fe_2O_3, incorporated sol was drop into mineral oil/ammonia solution filled with mineral oil at 100 °C

Obtaining Granules

Filtered and dried at 50 °C. Finally calcined at 450 °C.

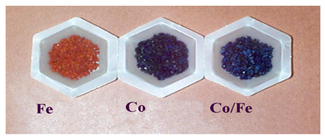
Sol-gel preparation system



Hydrogenation of Catalysts

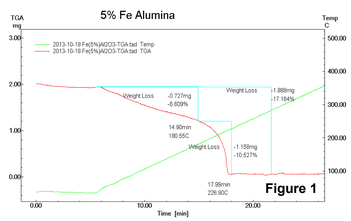
Hydrogenation Cycles

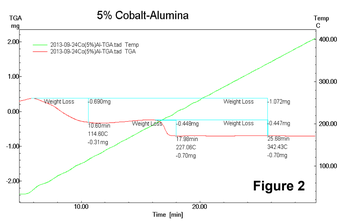
- **Hydrogen gas passed over the catalyst heated to 400 °C, 2 hrs.**
- **Catalyst dried and water removed by vacuum suction at 400 °C, 1hr**
- **Hydrogen gas passed over the catalyst heated to 400 °C, 2 hrs.**
- **Catalyst dried and by vacuum suction at 400 °C, 1hr**

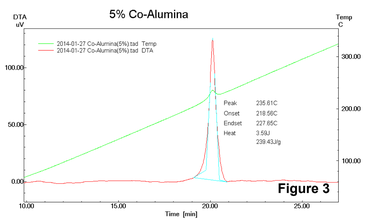


Results

Thermal Analysis DTA &TGA







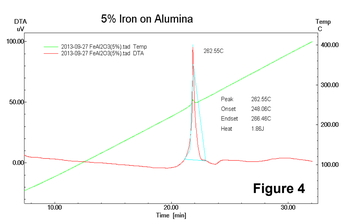
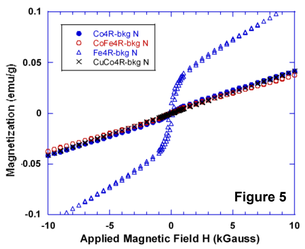
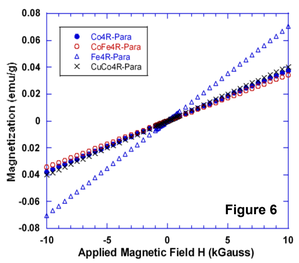
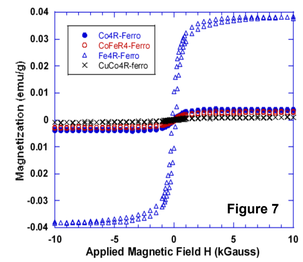


Fig. 1: 5% Fe Alumina TGA
Fig. 2: 5% Co Alumina TGA
Fig. 3: 5% Co Alumina DTA
Fig. 4: 5% Fe Alumina DTA
Fig. 5: Normalized data of reduced catalyst.
Fig. 6: Paramagnetic Components
Fig. 7: Ferromagnetic Components

VSM Analysis







Conclusion

From our results, we were not able to make a conclusion for the hydrogenation of catalysts at GSU. The present reduced samples, especially Fe catalyst, still showed a brownish color, indicating the samples were not completely reduced. This could be a result of a very slow flow rate of hydrogen gas. Reduction will need to be repeated for a longer period of time and with higher flow of hydrogen in order to make a reasonable conclusion. However, we were able to make a few other conclusions.

- **NiO, CoO. FeO, FeO/CoO, NiO/FeO alumina supported heterogeneous granular catalysts were successfully prepared by sol-gel-oil drop method**
- **Thermal analysis shows successful calcination below 450°C**
- **GC analysis and is successful using a TCD detector in identifying hydrocarbon and quantifying catalytic activity**

Acknowledgements

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