Synthesis of Catalytic Gold Nanoparticles for Oxidation of Benzyl Alcohol

Shirley Peng1, Mei Shan Ng2, Edgar Catari3, Mario Meneghetti3
1SUNY Oswego, 2SUNY Binghamton, 3Federal University of Alagoas

Introduction
- Nanoscale gold particles have attractive size and optical properties ideal for catalytic activities
- Properties and behaviors of nanoparticles are size-dependent
- High surface area in relation to its volume makes nanoscale materials more reactive than larger-scale materials
- Gold nanoparticles are an extremely efficient, green catalyst since they offer the possibility of catalytic oxidation that uses atmospheric air as the oxidant and forms water as the only byproduct

Objectives
- Synthesis and characterization of gold hollow mesoporous silica spheres with worm channels
- Application of the prepared nanoparticles as a catalyst in the oxidation of benzyl alcohol

Experimental Procedures
- Preparation of AuNPs
  - 9.16mL of HAuCl4 dissolved in deionized water to make a 150mL solution
  - Addition of 3% w/w sodium citrate (0.15g) in deionized water to reduce Au3+ to Au0 (reflux for 30 minutes)
  - Addition of PVP to isolate the gold nanoparticles and keep it from clustering (stir for 24 hours)
  - Centrifuge mixture twice and wash once with water
  - 15,000 RPM for 15 minutes
- Preparation of silica coating on AuNPs
  - 460 mL of isopropanol, 66 mL of deionized water, 12.8 mL of ammonia (stir for a few minutes)
  - Nanoparticles collected from centrifugation added to solution
  - Addition of TEOS to create the silica outer layer (mixture stirred vigorously for at least 6 hours)
  - Centrifugation
  - Collect nanoparticles into one container and wash twice with water and once with ethanol
  - 15,000 RPM for 15 minutes
  - Dry in oven for 24 hours between 80-85°C
- Preparation of Au@HMSS with Worm Channels
  - CTAB dissolved in 100mL of deionized water
  - 0.5013g of dried nanoparticles dispersed in 100mL of deionized water by ultrasonification
  - Suspended nanoparticle/water mixture added into CTAB solution (stir for 24 hours at 35°C)
  - Centrifugation
  - Collect nanoparticles into one tube and wash 4 times with water and twice with ethanol
  - 12,000 RPM for 12 minutes
  - Dry in oven between 80-85°C
- Oxidation of Benzyl Alcohol
  - 5mg of catalyst
  - 10 mL of benzyl alcohol
  - Temperature: 160°C
  - Pressure: 5 bars of oxygen
  - Duration: 6 hours

Results
- IR Spectra of gold nanoparticles before and after calcination (Figure 1)
- UV-Vis analysis after calcination (Figure 2)
- Adsorption and desorption on surface of silica (Figure 3)
- Analysis of pore size distribution (Figure 4)

Acknowledgements

References

Conclusion
The results show that the synthesis of gold hollow mesoporous silica spheres was achieved in this experiment. The future perspectives are to test the results of the benzyl alcohol oxidation using gas chromatography along with using the catalyst in an oxidation of glycerol where the HPLC will be used to analyze the results.