

FMRI RET 2014-Synthesis of Shape-controlled Bimetallic Nanoparticles for Photocatalysis

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Abstract

Nanostructures of a particular size and shape have been shown to improve catalytic activity and selectivity. The nanocube, due to its sharp corners and edges and of a particular size (30-70 nm), have shown promise in a variety of applications including plasmonics and catalysis due to its unique optical properties. In plasmonics, silver nanocubes serve as guides to direct light to specific locations with precision. Although silver nanocubes have excellent optical properties, they have limited catalysis capability. Ruthenium particles have excellent catalysis capabilities. To take advantage of both unique properties, a core-shell synthesis is used and a sample is deposited on an oxide semiconductor to test the catalysis.

Motivation

The purpose of this study is to epitaxially grow the ruthenium onto the silver substrate to take advantage of each metals' individual characteristics to enhance catalysis.

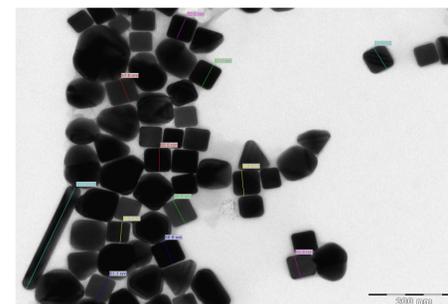
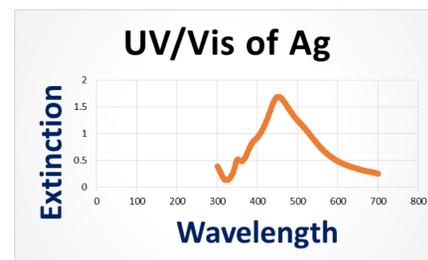
Synthesis & Characterization

Ag Synthesis

1. Heat 30 mL of ethylene glycol to 150° C
2. Add 360mL NaSH - wait 2 min. Aides in formation of single-crystal seeds along with HCl – oxidative etching
3. Add .1583 g of poly (vinylpyrrolidone) (PVP) & 3μL HCl. PVP acts as stabilizer and binds to form cubes. Wait 2 min.
4. Add .1497 g of CF₃COOAg. Heat for 1 hour.



Ag Characterization



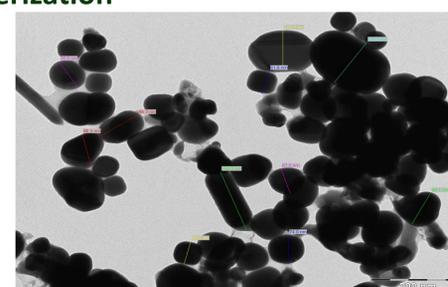
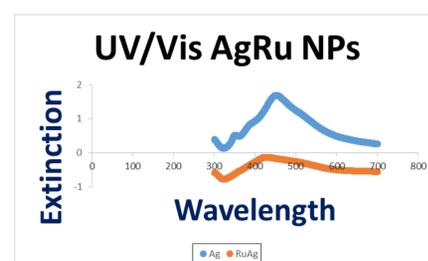
TEM image of Ag NPs

AgRu Core Shell Synthesis

1. Heat AgNC to 90° C
2. Add .1611 g of PVP
3. Add .0163 g of Ru
4. Heat for 1 ½ hours



AgRu Characterization



TEM image of AgRu NPs

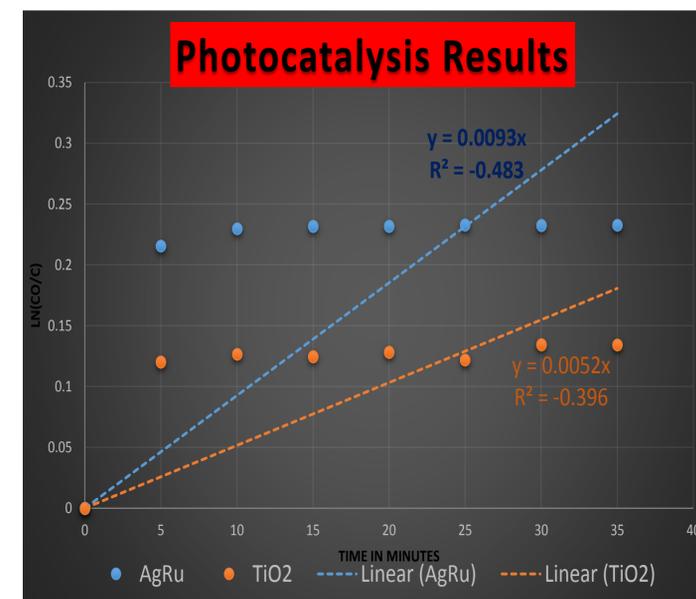
Loading .3% of bimetallic NP's in 3.8 mL of ethyl glycol onto 169 mg of TiO₂



Photocatalytic Reaction: Add 1.7 mg of Rose Bengal to 100 mL of H₂O; add .1003 g of AgRu



Results of Photocatalysis



Conclusion & Future Research

The growth of the ruthenium onto the silver nanocubes appeared successful, however, further work is required to control the synthesis. In addition, more catalysis and characterization experiments should be conducted to determine if the plasmonic and catalytic roles of Ag and Ru are respectively in operation as postulated.

References & Acknowledgements

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