Seminar Speaker: Dr. Stephany Garcia McClements

Strategic Partnership Lead

National Renewable Energy Laboratory

Questions from Stephany García, Rachel M. Anderson, Hugo Celio, Naween Dahal,

Andrei Dolocan, Jiping Zhou, Simon M. Humphrey. *Chemical Communications (ChemComm)*, **2013**, *49,* 4241-4243. <https://doi.org/10.1039/C3CC40387D>

Time management: this assignment should take no more than 1-2 hours.

Answers due at the beginning of class Friday Sept. 12th.

**No cut and paste allowed.**

**SA** = a word, a phrase, a sentence encompassing just one idea. **¶** = longer more cohesive answer in paragraph format, one that will provide more detail. **Cit**. means include a proper citation. If a question does not ask for a citation, that means you should be able to figure out the answer on your own based on the data or discussion provided in the article. **Chem Draw** - be sure to use the 1996 ACS template. *Don’t scale your drawings*.

1. Introduction

1. What are noble metals? Why are they referred to as “noble”? (SA, cit)
2. What are nanoparticles? What is the typical range in diameter for nanoparticles? (SA, cit.)
3. Draw an example of a heterogeneously-catalyzed hydrogenation reaction of an alkene. Include the structures and phases of the reactants, products and catalyst. (ChemDraw, cit.)
4. If a reaction occurs *only on the top* *surface* of a cube with an edge length of 1 cm, what would the ratio of the reactive area to the volume be? Compare that to sphere with a radius of 1 cm. The formula for surface area of a sphere is 4πr2 and volume of a sphere is 4/3πr3. Explain the implications of this result for catalytic performance of nanoparticles compared to bulk materials. (SA)
5. What are mixed noble metal core-shell nanoparticles? (SA, cit.)
6. Core shell nanoparticles afford the opportunity to modify the electronic properties of the nanoparticle by varying its composition. The electronic effects on catalysis can be understood in terms of the d band model. Explain how this model accounts for the bond strength of adsorbates on the surface of metals in terms of the energy of the d band center relative to the Fermi level. (**¶**, cit.)
7. Another means by which core shell nanoparticles can afford enhanced catalytic properties as compared to pure metals is through atomic ensemble effects. Explain the origin of enhanced catalytic activity through atomic ensemble effects. (**¶**, cit.)
8. Explain the difference between “top down” vs. “bottom up” nanoparticle production. (SA, cit)
9. Briefly outline the steps of the synthesis of mixed noble metal core shell nanoparticles. What is the role of capping agents? (**¶**, cit.)
10. How does microwave-assisted heating (MwH) differ from conventional heating (SA, cit)
11. What are the key benefits of MwH as compared to conventional heating in the synthesis of noble metal nanoparticles such as Rh, Pd, or Pt? (SA)
12. What are four reasons presented for exploring Au-Rh core-shell nanoparticles in this study? (SA)
13. It is noted Au and Rh both exhibit face-centered cubic lattices, with similar unit cell edge lengths. Sketch a face-centered cubic unit cell. Explain how a lattice mismatch could impact the catalytic activity of core shell nanoparticles. (**¶**, cit.)