

“Synthesis and Characterization of Nearly Monodisperse CdE Semiconductor Nanocrystallites”

Locate and read the paper of the same title by Murray, Norris and Bawendi, in *J. Am. Chem. Soc.* **1993**, *115*, 8706-8715. Answer the questions below, which focus on the first five pages of the paper.

1. The paper notes that the HOMO-LUMO gap widens with decreasing crystalline size, in the nanoparticle regime. Why is this?
2. Let's do some quick “back of the envelope” calculations to see how many CdSe “units” are in some different particle sizes. State any assumptions that you make and show your work.
 - a. How many CdSe units are in a 12 Å particle (the smallest they report?). In this case assume that it is spherical.
 - b. How many CdSe units are in a 115 Å particle (the largest they report?) In this case assume that it is a cube. (Hint—for bulk CdSe, the edge length of the unit cell is 6.05 Å, and it has the zinc blende (ZnS) structure.)
 - c. How many CdSe units are in a cubic crystal with an edge length of 0.1 mm (a non-nanoparticle, but about the smallest that one can see with the naked eye)?
3. Write balanced equations for the reactions that produce CdSe via Method 1.
4. Write balanced equations for the reactions that produce CdSe via Method 2.
5. In the isolation part of the preparation, the terms “floculation/flocculent” are used. What does this mean?
6. Explain why the synthesis reported here produces *nanoparticles* of CdSe and not just a *precipitate* of CdSe. (There are a couple of aspects of the procedure that favor forming nanoparticles. What are they?)
7. Figure 2 shows the optical absorption spectra of a related series of compounds. Do the absorption spectra maxima (which are related to the bandgap) change in the direction you would predict? Explain.
8. Explain figure 3.
9. Explain figure 5. (What does the absorption spectrum tell us? The fluorescence spectrum?)
10. The CdE species are characterized as having the wurtzite structure. What is this? What is the related alternate structure that you are more familiar with?
11. Briefly explain how a) TEM and b) powder x-ray diffraction were used to characterize the nanoparticles. (what information do each of these techniques supply?)
12. The nanoparticles are described as being “prolate”. What does that mean?
13. The title of the paper includes the word “monodisperse”. What does this mean?
14. The corresponding author on this paper (Bawendi) received a major award from the ACS in 2010. The citation for the award in *Chemical and Engineering News* specifically mentions this paper as one of his most significant achievements. Based on your reading of this paper, why is it so important?