Capsule Construction Investigations
Using Polyvinyl alcohol and Vegetable oil

Figure 1 Images taken through a light microscope ocular 400x.

Figure 2 Image with Red Oil O 100x.

Figure 3 Image with Red Oil O and Chloroform 400x.

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Standard 4-3.100 xxvi apply the adage "like dissolves like" to real-world situations.

Physical Setting Standard 3.2c Become familiar with types of organic reactions include addition, substitution, polymerization, esterification, fermentation, Saponification, and combustion.

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Introduction:

Capsules have been around for a long time. In 1957 BK Green and L. Schleicher popularized the idea with a US patent for what we commonly call NCR or no carbon required paper. That copying process requires small capsules on the paper, which break and release the chemicals for the copying process. The idea behind the formation of capsules is to take two solutions with different polar properties, for instance oil and water and then stir them so that little droplets are formed. While the droplets are present a molecule, which has the ability to exist in both solutions and polymerize with itself, coats the droplets and forms a capsule. Capsules like this are used in many food substances, cosmetic treatment, and medical applications including drug delivery systems. I had the opportunity in the summer of 2004 to work with Dr. T. McQuade and his research group who hope to use capsules as vessels for organic reactions as a way of speeding up the process of organic synthesis.

Materials:

Polyvinyl alcohol (PVA)
Vegetable Oil
Acetone
Borax
Oil soluble dye (optional)
Red Oil O, Sudan Black B
Water
Stir plate with magnetic stir bar
Microscope

Procedure:

1) Pour 50 ml of distilled water into a 250 ml beaker and stir as high as practical, and heat to 45^{o}C add .05 grams of PVA, allow time for it to dissolve.

2) After the PVA is ALL dissolved add 2ml of an oil/acetone stock solution made of 8 ml oil in 100 ml of acetone with oil soluble dye if desired, last add 1 ml of saturated borax solution, continue to stir for 15 minute.

3) Now the capsules can be removed and examined under a light microscope at 100x or greater magnification.

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Potential Educational Applications:

Plan	Time	Description
1) Class Demonstration	**20 min.**	**Have capsules prepared ahead of time so that upon entry to class students can look at the capsules under the microscope even before class begins. Show one sample with the dye encapsulated and one without, as an introduction into solubility rules, the dye could be either oil or water soluble, it will reside in a similar environment (inside oil, outside water).**
2) Class Laboratory	**40 min.**	**Have students make the capsules and change the following conditions; concentrations of PVA, oil, borax, also the pH, temp., and stirring speed all which alter the capsule size.**
3) Individual student research	**as interested**	**A single student could easily change the conditions that the capsules are made with and record microscope images to validate capsule changes. It is even feasible to have the student encapsulate different molecules that are nonpolar.**

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SUMMARY

Skills and Concepts:

The skills depending on the use of this activity could include, critical thinking, measuring volume and mass, microscope use, and practice creating experimental designs. The main concepts in this activity include solubility rules: 1) polar compounds dissolve in polar solvents and nonpolar compounds dissolve in nonpolar solvents, 2) monomers can link together to form polymers, which can form capsules.

Grade Subject/Theme/Level:

This activity is designed for 11th grade chemistry students and the more capable the student the more freedom to explore the system should be given.

Two different themes are central to this activity the first is solubility rules and the second is the organic polymerization reaction.

Other high school themes include careful measurement critical thinking when comparing different procedures and their outcomes. This activity could be performed as a demonstration for lower level students, as a lab for regents level students and it would make a fine science fair project for advance level students.

ASSESSMENT

It would be my suggestion to assess the demonstration in a test format using multiple choice questions or short answer. The lab activity should require a written report. The science fair competition should be the assessment for the student project version of this activity.

RESOURCES

1) http://chem.lapeer.org/chem 1 docs/SlimeDemo.html
"Polyvinyl alcohol slime" 2003

2) Rajaonarivony, M., Journal of Pharmaceutical Sciences vol. 82, no. 9 Sept. (1993) 912-917, Development of a new drug carrier made from alginate.

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3) Fallouh, N.A.K., International Journal of Pharmaceutics, 28 (1986) 125-132, Development of a new process for the manufacture of polyisobutylcyanoacrylate nanocapsules.

4) Bernstein, H., United States Patent 6,730,322, May 4, 2004, Matrices formed of polymer and hydrophobic compounds for use in drug delivery.

5) http://www.princeton.edu/~pccm/outreach/news/summerprogram.htm, Summer Program for High School Students gives opportunity to conduct research, work with faculty

6) http://www.rtdodge.com/fl-ovrvw.html, Flavor Encapsulation - An Overview Ronald J. Versic, Ph.D. President, Ronald T. Dodge Company

Contributors

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2) Dr. T. McQuade, Cornell University, ST Olin, Ithaca, NY

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