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ETHICAL BEHAVIOR
A Story

Mr. Albert C. Holler, FAIC

*As CEO of a large company, do I take stock options, my high salary, etc., for my compensation for the year? This total will be **120 million dollars.** As the CEO, I know that the company is "bleeding" with a debt of **26 billion dollars**!*

I have over the years "wined" and "dined" ethics. Now knocking at the door is "greed." Which do I choose? The door has no latch on the outside. Do I open it for my "greedy" self or keep it shut for my loyal employees? Is the word "ethics" still to be my goal and behavior now and in the future or does "greed" keep knocking at the door and I in a moment of weakness let him in?

Let's look briefly at each for a moment:

Ethics

Since childhood, I (ACH) have learned about fair play, sportsmanship, honesty, integrity and to be trustworthy, believe in God are the ways to go through life. Treat other people, your employees, and associates the way you would like to be treated. Nice things happen to ethical persons.

- You can sleep at nights!
- No federal agents or other people will come to you with subpoenas to open your books and financial files.
- Your accountants and outside consultants will not "cook the books."
- Why not divide the **120 million dollars** among your employees? It may not be very much for each but you will have their respect for an ethical leader. They will do anything for you!

Greed

Does "greed" overshadow "ethics"? Only you can help your employees bring back a healthy life to your company. Your "greed" will not do it! Help them!

- A couple of asterisk remarks:
    - *It all comes out even at the end of the day!* (***Winston Churchill***)
    - *The mills of the god's grind slowly but exceedingly fine!* ***(A Chinese proverb)***

"Greed" leads its distrust and disgust for you. Ethical behavior leads to a well-lived respectable life for you.

Do you as a member of the American Institute of Chemists subscribe and put into practice the ***AIC Code of Ethics***?

<u>Reread it</u> and give it some deep thought. **<u>Note</u>** especially the items 1 thru 11. Don't let "greed" into your life!

AIC PRESIDENT'S MESSAGE…

EVOLVING PERCEPTIONS

David Riley

Communications is an important aspect of the Institute. One aspect of this is the desire of our members to search for answers to the complex topic of professionalism. We attempt to do this in many different forms, one of which being *The Chemist*. Yes, we have some technical papers in our journal because there must be a connection between the ethereal aspect of professionalism and the real scientific world of activity; however, we must also set the pattern for interpretation of all elements of our technical life. The professional aspect of the American Institute of Chemists is copied by many others (this is the leadership quality of professionalism) and involves not only our *Code of Ethics* and the quality of our professional life, but also how well we apply the Scientific Method to all our endeavors. How, you say, does the Method become our way of life (look at the means by which we run our lives)? Do we take what we see for granted (and make unreasonable errors as a consequence)? Or, do we look to see if there are other sides to all questions? Indeed, the latter case is our mode for life—it is to our inane curiosity. Furthermore, we also test what we do and ask for pertinent information that applies to each subject, no matter how trivial it is. Some of us have a penchant for measuring how well an answer represents what we want to do with it.

Since it is near and dear to our hearts, let us look at the basis of the Scientific Method. Our every day activity might be clearer if we looked at this technique. How do we start? A premise (or figment of our imagination) occurs to us. This premise can be world-shaking or simply a new venture in a usually technical topic. It usually requires some rational thought or direction. It is conceivably untenable after we think about it; hence, the premise is discarded as useless. In contrast, there usually is some basis of reasoning as to why we initially conjured up the premise. Frequently, the reason for the thought is some technical program, need, or basic knowledge that we have. Or it may be due to some experience that we have had. This is why we need to have technical articles in *The Chemist*. Otherwise, the journal would simply be called "The Thought." After all, even though we may have widely divergent interests and activities, we are all chemists.

The premise, then, is a conceivably pertinent idea or direction. How do we judge the value of a premise? We inspect the various aspects of the premise and try to ascertain if it might have some reason for further thought. In mathematics, it is quite clear that an exact answer can then be derived. This is why, in scientific terms, the rigor of mathematics is desired and needed. This is also why it is necessary for someone skilled in the art to develop the simplest terms for expressing the relationships involved in a premise. Mathematics also allows us to express these relationships in measurable terms, such as levels of uncertainty or, more commonly, by standard deviations.

For example; 40 years ago, I was employed by a branch of AT&T known as Western Electric. Western Electric hired me to study its extruders and the processing of poly(vinyl chloride), or PVC. PVC is the primary insulation for wires and cables. No one had been able to get consistent processing of PVC or even run a melt flow test on PVC because it was inherently unstable. I bought $150,000 worth of equipment including an Instron capillary rheometer, an infrared spectrometer, a gas chromatograph, a roll mill, and a melt indexer. I also joined the American Society of Testing and Materials (ASTM) to learn as much as I could. After a few months of study, I concluded that, with the Instron Capillary rheometer and information from the infrared spectrophotometer, the most meaningful information I could get was from the melt indexer. I could, with this simple tool, determine the degree of instability with a long land die and a low temperature (175°C), a high weight on the ram (20 kg), and a low charge in the bore (2.15 g). I found that the PVC, after being sheared in an extruder, first decreased in molecular weight (increase in flow in the melt indexer) and then significantly increased in molecular weight through more shearing (decreased flow in the melt indexer). My basic premise was that the shearing initially caused the molecules of PVC to be broken apart into smaller pieces, then eventually, the free radicals of the broken fragments would recombine into larger, more complex but stable molecules. Everything I tested gave me the same results; so after a few thousand of these tests, I concluded I was right and began to publish my results, expounding the data as a purported hypothesis. This is the next step of building a theory. But even with this remarkable amount of data, I knew I needed additional corroboration. As a new technique, I extracted the plasticizer and found the viscosity of the extract increased over that of the original plasticizer. If I dissolved PVC in the plasticizer, I found that a small percentage increased the viscosity over that of the original plasticizer by the amount equal to that of the extracted material. I therefore concluded the hypothesis proven. I now had a real theory.

I went to ASTM and developed the technique for running both the melt indexer and the extraction as standard methods; the importance of this was that it employed a round robin system to prove others could get the same answers. After adequate round robins, proving that others could duplicate my results, I established two new methods: The Standard Method for Determining the Melt Flow of PVC and other Unstable Polymers, designated ASTM D 3364, and the Standard Method for Measuring the Logarithmic Viscosity Number on Processed PVC, designated ASTM D-3591.

Furthermore, by testing the solubility of the PVC after being exposed to various temperatures from 175 to 190 to 200 to 210 to 220°C, I developed a picture of increase in molecular weight through progressive crosslinking that demonstrated, with temperature, the solubility of PVC in tetrahydrofuran (a good solvent for PVC) decreased directly as the temperature increase (QED). Of course, the definition of a polymer being crosslinked is that the polymer be totally insoluble in a good solvent. Therefore, I developed the term “incipient crosslinking” to indicate this progressively increasing measure of molecular growth.

In conjunction with this increasing insolubility, I observed a progressive change in the color I could associate with the increase in consecutive double bond formation in the PVC structure that is indicative of the controlled selective process of removing HCl from adjacent vinyl chloride segments of the polymer. After the double bond formation reaches six to ten members, a progressive color formation occurs, indicating a selective and controlled process of molecular change. This fit with my theory of molecular shifting and potential growth.

For 30 years, I observed this same phenomenon with tens of thousands of samples and thought my theory was secure. Only two flies appeared in the ointment. When the plasticizer content got to be almost 50% of the formulation, the plastic could be sheared as much as one could apply to it without change in molecular structure. And, when one of my clients used specific fire retardants aluminum oxide trihydrate combined with molybdenum disulfide, the molecular structure had no severe crosslinking; only some increase in the rate of flow, indicating that the fire retardants were capable of controlling the free radicals that were so effective in unmodified PVC in creating higher and higher molecular structures.

Therefore, the theory had to be modified to indicate that, if the level of plasticizer were high enough (50% or more of the composition), the softness of the compound protected the molecules of PVC from the effects of shear. Also, if the free radicals were protected by adequate stabilization such as the fire retardants listed above, only small fragments could be formed in a stable manner, probably by reforming into stable coupled fragments.

Meanwhile, other experimentalists verified my theory. Roger Pinette, in an independent study at Belden Wire Corporation, using the same technique, ASTM D 3364, found that at low temperatures and low shear, small fragments were formed and that increased molecular weight materials were formed as the temperature and shear rate increased in Brabender studies made independently. The molecular specie that was still part of the PVC main frame without resulting in a gel had an average molecular weight of four million determined by size exclusion chromatography (SEC).

Subsequent to that, in a court case, a study of an over-worked PVC film was found by SEC to have the same average molecular weight of four million found by Mr. Pinette, confirming that that level of molecular weight growth was duplicable.

Based on this theoretical background, I attempted to extrapolate my data with known molecules of sizes similar to the fragments that might be formed by the shear process. I found that the linear relationship existed on a log-log scale from one to nine carbon atoms for hydrocarbon molecules for both saturated and unsaturated linear structures. Based on this, I extrapolated chlorine-modified structures like PVC and surmised that the extracts from sheared PVC should lie in the four to eight regions of vinyl chloride type molecules. Some extracts, however, measured closer to 10, indicating that I might not know how to handle the data. At any rate, I decided to publish the results and ran into a hornet's nest. The reviewers would not accept my extrapolation.

Imagine my additional shock too, when pursuing the structural investigation further, that extracts of rigid PVC by the method ASTM D 3591 studied using NMR displayed no evidence of chlorine in the sample. Subsequent investigation indicated the extract was actually fragments of the high molecular weight processing aid, polymethlyl methacrylate, that also was sheared in the process in a manner that I had assumed was the action on PVC. In a sense, this verified the technique of the theory because the PMMA was selectively sheared rather than the PVC.

As a matter of reference, we have independently observed this phenomenon of shear to be present in other polymers as well. Polypropylene is somewhat susceptible to this (about half the susceptibility of PVC) and to a less degree, high-density polyethylene and polybutylene.

Therefore, we conclude that even though a theory can be quite advanced it must be continuously inspected for flaws and shortcomings before being accepted.

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COBALT(I) SALT FORMATION IN HYDROFORMYLATION CATALYSIS

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Abstract
High-pressure in-situ nuclear magnetic resonance (NMR) spectroscopy was used to study reactions of carbon monoxide with cobalt complexes of the type, $[Co(CO)_3L]_2$, where L = tertiary phosphine, that are used as catalysts in the phosphine-modified hydroformylation of olefins. For the case where L is the relatively basic phosphine, $P(n\text{-}C_4H_9)_3$, high pressures of carbon monoxide cause CO addition and disproportionation of the catalyst to produce a catalytically inactive cobalt(I) salt with the composition $[Co(CO)_3L_2]^+[Co(CO)_4]^-$. The reaction is exothermic in benzene solution with $\Delta H = -14.1 \pm 0.1$ Kcal/mol and $\Delta S = -48.6 \pm 0.2$ eu. Salt formation is favored by polar solvents, and for the case where L is the water soluble phosphine, $P(CH_2CH_2CH_2OH)_3$, cobalt(I) salt formation proceeds essentially to completion in water. For the case where L is the weakly basic phosphine, $P(C_6H_4CF_3)_3$, high pressures of carbon monoxide do not result in salt formation; instead, displacement of the phosphine ligand occurs with the formation of mixtures of $[Co(CO)_4L]_2$, $Co_2(CO)_7L$, and $Co_2(CO)_8$

Introduction

Although homogeneous catalysts are often associated with the production of pharmaceuticals and other fine chemicals, they are also important in a number of large-scale industrial processes. Most notably, catalytic reactions involving the addition of CO, either by itself, or with the coaddition of hydrogen are of extreme industrial importance, while also being to a considerable degree the exclusive domain of homogeneous catalysis. For example, the hydroformylation of olefins is conducted on a 7 million ton/year scale using cobalt and rhodium carbonyl, and carbonyl phosphine complexes (1). Other than anchored homogeneous catalysts, however, there do not appear to be any heterogeneous analogs for the hydroformylation reaction. Cobalt carbonyl catalysts and their phosphine modified analogues are remarkable among carbonylation catalysts, not only for their overall economic value and for their relatively low cost, but also for their versatility. Thus, $HCo(CO)_4$ is active for the oxo and Reppe carbonylations of olefins to yield aldehydes and alcohols, and (in the case of the Reppe carbonylation) to yield carboxylic acids (2). It is also active both for the homologation of methanol in nonaqueous solvents to produce higher alcohols and for the aqueous-phase carbonylation of methanol to produce acetic acid in the BASF process (3-5). Cobalt carbonyl catalyzed carbonylations of formaldehyde and ethylene oxide have been studied for use in the production of ethylene and propylene glycols (6-8). While certainly not competitive with the commercial heterogeneous methanol synthesis catalysts, $HCo(CO)_4$ and its phosphine modified analogs are active in CO hydrogenation (9). Of particular relevance to this article, phosphine modified cobalt catalysts are used in the Shell Process for the large-scale production (400,000 tons/year) of long-chain alcohols via hydroformylation and further reduction of terminal/internal olefin substrates (1). Here we describe reactions of CO at high pressures with phosphine-modified catalysts of the Shell-type, i.e., $[Co(CO)_3L]_2$, where L = tertiary phosphine. Dependent upon the choice of L, solvent, and reaction temperature, CO reacts with the catalysts to produce a cobalt (I) salt by CO addition and disproportionation as shown in Eqn. 1.

$$[Co(CO)_3L]_2 + CO = [Co(CO)_3L_2]^+ + [Co(CO)_4]^- \quad (1)$$

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Or, it reacts by displacement of one or both phosphines in the catalyst as shown in Eqns. 2 and 3.

$$[Co(CO)_3L]_2 + CO = Co_2(CO)_7L + L \quad (2)$$

$$[Co(CO)_3L]_2 + 2\ CO = Co_2(CO)_8 + 2\ L \quad (3)$$

Both the disproportionation and the ligand substitution reactions shown in these equations lower the efficiency of the desired catalytic process. Disproportionation decreases the catalyst available for reaction with H_2 to form the necessary hydridic species, $HCo(CO)_3L$, required in the catalytic process. Displacement of the phosphine ligand, to the extent that the products of Eqns. 2 and 3 lead to the formation of unsubstituted $HCo(CO)_4$, decreases the selectivity of the process to produce the more desirable linear alcohol product favored by the steric bulk of the tertiary phosphine ligand.

The in-situ high-pressure NMR measurements described here provide some insight into mitigating the effects of these detrimental reactions, not only in the Shell Process, but also in potential phosphine-modified versions of the aforementioned assortment of catalytic processes for which $HCo(CO)_4$ is active.

Experimental Section

^{31}P NMR spectra were recorded at 121.4 MHz with chemical shifts relative to 85% phosphoric acid at 0.0 PPM using a General Electric GN 300 spectrometer equipped with an 89-mm Oxford magnet. Measurements of equilibrium data employed a variable temperature high-pressure Be-Cu NMR probe containing an internal toroid detector that was designed in-house and has been described previously (9). The ligands $P(n\text{-}C_4H_9)_3$, $P(C_6H_5CF_3)_3$, and $P(CH_2CH_2CH_2OH)_3$ were purchased from Strem Chemical Company. The catalysts, $[Co(CO)_3L]_2$, were prepared by reaction of $Co_2(CO)_8$ with the phosphorus ligand, similar to a literature procedure but adapted to the tertiary phosphines used here (10). In each case the pressure probe was charged with preformed catalyst, where $L = P(n\text{-}C_4H_9)_3$ and $P(C_6H_5CF_3)_3$, or with the ingredients for the catalyst ($(Co_2(CO)_8$ and $P(CH_2CH_2\ CH_2OH)_3)$ in the case where $L = P(CH_2CH_2CH_2OH)_3$ using an inert atmosphere glove box. The equilibrium constants used in the van't Hoff plots were measured as K_p values with $K_p = [salt]/[catalyst]\cdot P_{CO}$ and have units of atm^{-1}. For the typical case of equilibrium measurements of the conversion of $[Co(CO)_3P(n\text{-}C_4H_9)_3]_2$ to the salt $[Co(CO_3(P(n\text{-}C_4H_9)_3)_2]^+\ [Co(CO)_4]^-$ in benzene solution, the NMR probe was loaded with 125 mg of the catalyst and 6.0 ml of benzene. The probe was then placed into the NMR magnet and was purged with CO and then pressurized with CO (77.7 atm at 22.4 ^oC). Equilibrium data obtained by measurement of the CO pressure and integration of the ^{31}P NMR signals of the catalyst at $\delta = 53.1$ PPM and the salt at $\delta = 51.9$ PPM were collected at 75, 100, 125, 150, and 175 ^oC. Data for the equilibrium constant at 75 ^oC was compared as a function of increasing and decreasing temperature (and at 100 ^oC, as a function of increasing and decreasing pressure) to ensure that the reaction measured was reversible. Similarly, thermodynamic data were also obtained for salt formation in 1,4-dioxane solution. Displacement of the $P(n\text{-}C_4H_9)_3$ by CO (via Eqns. 2 and 3) did not occur to an appreciable extent in either solvent with this ligand as shown by monitoring the free ligand signal at $\delta = -32.5$ PPM. Salt formation did not occur with the catalyst, $[Co\ (CO)_3P(C_6H_4CF_3)_3]_2$; instead, significant displacement of the phosphine ligand by CO as exhibited via the monitoring of the ^{31}P NMR signals for $[Co(CO)_3P(C_6H_4CF_3)_3]_2$, $Co_2(CO)_7P\ (C_6H_4CF_3)_3$, and $P(C_6H_4CF_3)_3$ at $\delta = 67.2$ PPM, $\delta = 64.1$ PPM and $\delta = -5.8$ PPM, respectively. In experiments with aqueous solutions containing the ligand, $P(CH_2CH_2CH_2OH)_3$ ($\delta = -29.5$ PPM), salt formation was complete, and only the signal for $[Co(CO)_3(P(CH_2CH_2CH_2OH)_3)_2]^+\ [Co(CO)_4]^-$ at $\delta = 53.1$ PPM could be observed after equilibration with CO.

Results and Discussion

The van't Hoff plot for the conversion of $[Co(CO)_3P(n\text{-}C_4H_9)_3]_2$ to $[Co(CO)_3(P(n\text{-}C_4H_9)_3)_2]^+[Co(CO)_4]^-$ by reaction with CO in benzene solution is shown in Fig. 1. Thermodynamic results calculated from the slope and intercept of this plot indicate that the reaction is favorable and exothermic even in relatively non polar benzene solution. The large negative entropy change measured is consistent with the consumption of one equivalent of gas. Also, as expected for a reaction that produces charged species from uncharged reactants, the thermodynamic parameters, $\Delta H = -21.5 \pm 0.6$ Kcal/mol and $\Delta S = -65 \pm 1.4$ eu., measured in the more polar solvent, 1,4-dioxane, are even more favorable than in benzene. Consistent with this interpretation, formation of the Co(I) salt using the water soluble ligand $P(CH_2CH_2CH_2OH)_3$ in aqueous solution could not be measured because salt formation was complete in this highly polar solvent even at low CO pressures. In contrast, salt formation with the weakly basic ligand, $P(C_6H_4CF_3)_3$, was immeasurably low, at least for determinations made in toluene solution. Large excesses of free ligand (as high as 6 moles of ligand per mole of catalyst) were needed to mitigate the extensive displacement of the phosphine from the metal center in the presence of CO.

Conclusions

For the phosphine-modified cobalt catalyst, based on relatively basic tri-n-butylphosphine, formation of the Co(I) salt by CO addition and disproportionation is thermodynamically favorable and exothermic even in nonpolar benzene solution. With use of this ligand, salt formation is more favorable in the more polar solvent 1,4-dioxane. In contrast, displacement of the tri-n-butylphosphine with CO to form free ligand is not significant even at relatively high CO pressures. For this relatively basic ligand, salt formation can most effectively be minimized at high temperatures. Salt formation is disfavored due to the reaction's exothermicity plus the application of as low a CO pressure and the least polar solvent available. On the other hand, for catalysts using the weakly basic $P(C_6H_4CF_3)$ ligand, salt formation is not significant, even at high CO pressures, in toluene solution. Large excesses of added ligand are needed to avoid facile displacement of the phosphine by CO. For the catalyst system based on water soluble $P(CH_2CH_2CH_2OH)_3$, salt formation is complete in aqueous solution and no other complexes were detected in this highly polar solvent even at low pressures of CO.

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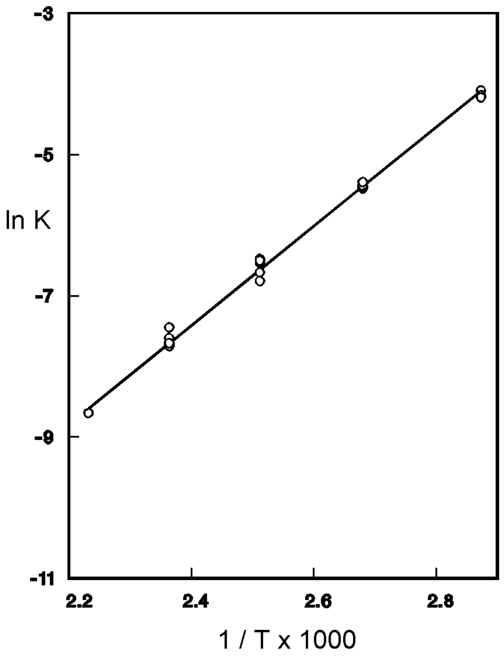
Figure 1

Van't Hoff plot for the conversion of $[Co(CO)_3P(n\text{-}C_4H_9)_3]_2$ to $[Co(CO_3(P(n\text{-}C_4H_9)_3)_2]^+[Co(CO)_4]^-$ by reaction with CO in benzene solution.



USING THE SENSES TO TURN STUDENTS ONTO CHEMISTRY: A COMPARISON BETWEEN THE UNITED STATES AND JAPAN

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Abstract

Chemistry researchers/educators in the United States and Japan have developed a method that uses the senses to turn students onto chemistry. This approach, known as the "Chemical Sensation Project," incorporates diverse learning styles to meet the needs of all students. It combines music, pictures, and hands-on experiments to provide multi sensory lessons that complement existing college / high school chemistry curriculums.

Introduction

Chemistry educators / researchers in the United States and Japan have developed a multi sensory method for teaching college and high school chemistry. Their creative approach, known as the "Chemical Sensation Project," uses diverse learning styles to meet the needs of all students. It combines music, pictures, and hands-on experiments to provide multi sensory lessons. These lessons are intended to be incorporated into the lecture component of existing chemistry courses.

In addition the program, which relates chemistry to daily life, gives students positive and meaningful experiences in science.

This collaborative effort to promote and enhance chemistry education is of great interest in Japan, where most students are taught by the face-to-face lecture method. The authors of this paper have already been invited, by prestigious Japanese organizations, to give presentations and to write journal features about this program.

Sponsors for this project include Suzuka National College of Technology in Japan and the Northern New York Section of the American Chemical Society.

Project Description

Materials used in this project include a music tape, overhead transparencies, pictures to serve as visual aids, hands-on chemical experiments and evaluation forms. The music tape, *Chemical Sensation with the Barry Tones*, contains songs that address many topics in high school / college chemistry curriculums (1). These songs were part of the science education television series *Sensational Science,* which aired in New York State in 1996 and 1997. Most students are interested in music, so it is a great way to capture their attention and turn them onto chemistry. The words to the science songs are on overhead transparencies and handouts that are distributed to the class.

Dr. Barry composed the music, wrote the lyrics for the science songs, and prepared the pictures and hands-on experiments for the program. Professor Kanematsu translated everything into Japanese for the students in Japan.

Below are the titles of songs and activities used to provide multi sensory lessons which complement existing high school / college chemistry curriculums.

Song: Organic Chemistry
Activities: (Hydrocarbons) and (Functional Groups)
Song: Acid Verses Base
Activities: (pH and Indicators) and (Acids and Bases)
Song: Chemicals
Activities: (Chemicals) and (Bonds)
Song: Fission and Fusion
Activities: (Half - Life) and (Helium and other Gases)
Song: Science Is
Activities: (Cooking) and (Walking)
Song: Matter and Energy
Activities:(Mixtures) and (Surface Tension)
Song: Periodic Table
Activities: (The Human Atom) and (Periodic Table of Items)

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Evaluations

The teachers/instructors complete simple evaluation forms describing the use of the program in their classes. Also students answer questions accompanying each chemical activity to provide educational outcome results. In addition, both students and instructors complete a form, which makes use of a semantic differential method.

Procedure

Participants begin by viewing the activity picture and words to the selected chemistry song, while listening to the song. Next they perform an exciting hands-on activity that complements the song. Finally they answer activity questions and complete the evaluation forms.

Multi Sensory Lesson

The following song and activity provide a multi sensory lesson to complement material in a high school chemistry unit about the Periodic Table.

PERIODIC TABLE
(music style: soft rock)
First Verse
S stands for sulfur and boron is B.
Cl stands for chlorine and carbon is C.
Na stands for sodium and helium's He.
Al's aluminum and phosphorus is P.

Second Verse
Metals are found on the table's left side.
Nonmetals are on the right where they hide.
Metals include sodium, copper, and gold.
Nonmetals are mainly gases I'm told.
Chorus
Periodic Table, Periodic Table.
Mendelev is given credit for the Periodic Table, Periodic Table.
It contains elements with a symbol for each label, symbol for each label.

Periodic Table Of Items

Question: Can you design a periodic table for a given set of items?

Information: The elements in the modern periodic table are arranged in order of increasing atomic number (number of protons). Each element has its own symbol. The periodic table has horizontal rows called periods. The elements in each period have the same number of principal energy levels. The periodic table also has vertical rows called groups or families. The elements in any group have similar physical and chemical properties. Elements on the left side of the table are metals. Metals tend to shine with a metallic luster when polished. Also they are good conductors of heat and electricity. Elements on the right side of the table are nonmetals. Nonmetals are mainly gases and dull solids. Also they are poor conductors of heat and electricity.

Activity: Use paper and a pencil to design a "Periodic Table of Items." Obtain the following ten items or other available items (toothpaste, shampoo, cracker, fruit, pencil, coin, aluminum foil, paper, water, and a paper clip). Closely examine each item. Look for similarities and differences. (Hint: Food items in a grocery store are arranged according to similar properties. For example, dairy products are grouped together in the same aisle or the same section of an aisle.) Refer to the "Periodic Table of the Elements" as a model to obtain design ideas for your "Periodic Table of Items." On the back of your table, write a brief description about its layout and organization.

Extension: Obtain samples of three elements that are in the same group of the "Periodic Table of the Elements." Examine them closely. Then briefly explain (in a short paragraph) why the three elements have been grouped together.

Pick your favorite element and write a report about it.

Results

The "Chemical Sensation Project," which is a multi sensory approach to learning, is intended to complement material in existing high school / college chemistry curriculums. The program was carried out at both the college and high school levels. Participant organizations include Clarkson University, Edwards-Knox High School and Canton High School in the United States and Suzuka National College of Technology, Takada High School, and Kanbe

High School in Japan. Evaluation results are provided.

Overall the class instructors participating in the program gave it a high rating. 100 % of the teachers and professors participating in the program had a neutral - very positive reaction to its theme (the combined use of songs and activities). They really liked the hands-on activities and the multi sensory approach to learning. They said that the chemical experiments were exciting, useful, and meaningful to the students. The instructors also liked the music component and believed it to be educational, entertaining, and relaxing. A constructive comment made by several Japanese instructors was that the songs might be more helpful to their students if they were sung in Japanese. (These students viewed the words in Japanese, while listening to the songs in English.)

Organic Chemistry Professor Hiroshi Shimofuruya, of Suzuka National College of Technology, said that his students learned a lot of chemistry by carrying out the exciting hands-on activities using hydrocarbons and functional groups. He was also impressed that the experiments included commodities used in daily life.

Edwards-Knox chemistry and physics teacher Amy Carr said that her class very much enjoyed the multi sensory lesson on acids and bases. She felt that it was very appealing to all students of all learning styles, including students with disabilities. Also she agreed that it would be wonderful to incorporate as many learning styles as possible.

One can say that the student participants as a whole very much enjoyed the program. They gave the songs a high rating and the hands-on activities a very high rating. See the chart at end of paper entitled " Chemistry Activities and Songs: U.S. Versus Japan." The lower rating of the songs by some of the Japanese students may be due to cultural differences, such as being accustomed to very different teaching styles. It is interesting to note that the Japanese students (at Takada High School) taught by the music's composer gave the songs a very high rating. The data show that the overall Japanese student reaction to the program is a little lower than that of the students in the U.S. However 94 % of all the student participants had a neutral -very positive reaction to the activities and 84 % of them had a neutral - very positive reaction to the songs.

Conclusion

The "Chemical Sensation Project," carried out by Professors Kanematsu, Kobayashi, and Shimofuruya (of Suzuka National College of Technology in Japan) and Dr. Barry (of Clarkson University in the U.S.), has been successful at both national and international levels. This unique method, which combines music and chemical activities, provides multi sensory lessons that complement existing chemistry courses. Students, who learn by seeing, view pictures and the words to the science songs. Also listening, writing, and hands-on activities are incorporated into the program. Student participants using this approach learned chemistry. After each lesson, they were required to answer chemistry questions. Over 96 % of the U.S. participants answered the questions correctly. In addition, the instructors and students found the program to be useful, challenging, and fun.

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Note: The program components (evaluation forms, songs, activities, etc.) are the property of the authors.

About the Authors

Dr. Dana M. Barry, a Certified Professional Chemist, is an External Professor for Ansted University in Malaysia and Editor/Technical Writer for Clarkson University's Center for Advanced Materials Processing. (For more information you may contact her at Box 5665 CAMP at Clarkson University in Potsdam, NY 13699 or send email to her at dmbarry@clarkson.edu).

The other authors are Professor Hideyuki Kanematsu, Professor Hiroshi Shimofuruya, and Professor Tatsumasa Kobayashi. They are members of the Materials Science and Engineering Department at Suzuka National College of Technology in Japan.

Chemistry Activities and Songs: US vs. Japan					
Organization	**Total Number Students**	**Hands-On Activities Category: Positive**		**Songs Category: Positive**	
		Number of Neutral-Very Positive Reaction Responses	% (Nearest Whole %)	Number of Neutral-Very Positive Reaction	% (Nearest Whole %)
Clarkson University (US)	28	28	100	26	93
Edwards-Knox High School (US)	20	20	100	18	90
Canton High School (US)	21	18	86	17	81
Total for 3 US Organizations	69	66	96	61	88
Suzuka National College of Technology, Japan	43	42	98	28	65
Takada High School, Japan	56	51	91	55	98
Kanbe High School, Japan	39	36	92	30	77
Total for 3 Japanese Organizations	138	129	93	113	82
Total for Both US and Japanese Organizations	207	195	94	174	84

BOOK REVIEWS

Advances in Photochemistry, Vol 27

Editors:	Douglas C. Neckers, William S. Jenks, and Thomas Wolff
Publisher:	John Wiley & Sons, Inc.
ISBN#	0-471-21451-5
Price:	$135.00

This is the most recent volume of the well-known Advances in Photochemistry series. As stated by the editors in the preface, the purpose of the series is to 'explore the frontiers of photochemistry through the medium of chapters written by pioneers who are experts' and 'have strong personal points of view'. Each chapter provides not just a simple literature survey, but more importantly, some critical discussions and evaluations of existing data.

The first chapter is about the supramolecularly organized luminescent dye molecules in the channels of zeolite L. It was written by Gion Calzaferri and colleagues in the Department of Chemistry and Biochemistry, University of Bern, Switzerland. In this chapter, the authors described the design and important properties of supramolecularly organized dye molecules in the channels of hexagonal zeolite L nanocrystals. The chapter showed that zeolite L is a very suitable host for the arrangement of a wide variety of chromophores. The chromophores can be aligned in a certain direction inside the channels and the formation of non-fluorescent dimers can be prohibited. This host-guest system can be used to make very efficient nanoscale two-directional photonic antenna systems. The preparation of the dye-zeolite systems was not covered in this chapter although references were provided.

Chapter 2, written by Kevin Peters at University of Colorado, is a excellent review on the photon-transfer reactions in benzophenone/N,N-Dimethylaniline photochemistry. After a brief introduction of the proton transfer process, the author presented an in-depth view of the mechanism for the photochemical reduction of benzophenone by N,N-dimethylaniline. This discussion is followed by an general introduction of various theoretical models, including Classical Model, Semiclassical Model, Proton Tunneling, Dogonadze-Kuznetsov-Levich (DKL) Model, Borgis-Hynes (BH) Model, and Lee-Hynes (LH) Model. The parameters controlling the dynamics of proton-transfer processes were described with comparison of Semiclassical and Quantum Models. A survey of the experimental studies in the author's own lab was then presented. Finally, the comparison of benzophenone/N,N-Dimethylaniline with other proton transfer molecular systems was briefly reviewed with focus on the latest studies.

Chapter 3 discusses the functional molecular glasses as building blocks for future optoelectronics. It was written by Thomas Fuhrmann and Josef Salbeck at Kassel University, Germany. After a brief introduction of the low-molecular glass and molecular materials for optoelectronics, the authors gave a through discussion on structural concepts for molecular glasses (including chelate complexes, twin molecules, starbust molecules, spiro molecules, tetrahedral molecules, and others). The optical (absorption and emission) properties of molecular glasses and doped systems were surveyed according to material types and their color ranges. The authors then presented a wide range of applications for thin-film devices from these materials with focus on the applications based on the interaction with light and electricity (including organic electroluminescent devices, solar cells, photochromic and photorefractive materials).

Overall, this book provided an authoritative resource on the current research achievements in some of the important areas in photochemistry. The introductory material is concise and the applications are up to data. All the chapters have references up to 2001 (some even to 2002) which enhances the merit of the book and also allow the readers to carry on further researches on these topics. This book and the series of which it is a part are of continuing value to the photochemistry community and should be a required acquisition for most libraries. Both researchers and graduate students interested in photochemistry will benefit from this book.
Reviewed by *Yushen Guo, Ph.D., FAIC*

Applications of Inorganic Mass Spectrometry

Author:	John R. DeLaeter
Publisher:	John C. Wiley and Sons
ISBN # :	047-134-5393
Price:	Unknown

Since its discovery, mass spectrometry has evolved into a powerful analytical technique being used effectively in both stand alone and hyphenated configurations. Applications of this technology currently span from academic, industrial, and pharmaceutical research laboratories to clinical and forensic laboratories. The hallmark feature of this technique is its analytical ability to present unequivocal molecular fingerprints of chemical entities of organic, biochemical, and inorganic origins. Inorganic mass spectrometry is an area that is not common or well understood by many practicing analytical specialists and as such, the important utility of this analytical instrumentation remains unrecognized. Therefore, the presence of “Applications of Inorganic Mass Spectrometry” by DeLaeter is a welcomed addition to this wealth of information.

The content of the text presented by DeLaeter is divided into an overview of instrumentation and applications of inorganic mass spectrometry. Each section is enriched with introductory material, tables, diagrams, and lucent discussion pertinent to a clear understanding of the topics developed. Complementary to text discussion are appendices of standard atomic weights and isotopic compositions of the elements under consideration in the body of the text. Where appropriate, each chapter begins with a historical perspective and is interwoven throughout the book. Mathematical development is minimized focusing on fundamental relationships and equations. This point will be greatly appreciated by readership of limited exposure to advanced mathematics as applied in this area. Plots and diagrams are truly reflective of the material present in the body of the text. DeLaeter incorporates his own research in this offering.

This reviewer was impressed with the diversity of applications addressed by this premier analytical technique. DeLaeter’s incorporation of the contemporary instrumentation and applications of Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FTICRMS), Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS), and Laser Ablation Microprobe-Inductively Coupled Plasma Mass Spectrometry (LAM-ICPMS) is meritorious. Discussions surrounding the application of inorganic mass spectrometry to forensic, biomedical and biological studies were limited in scope but served as a basis for further investigation for potential application to contemporary challenges outside of the scope of discussions presented in this chapter.

This textbook is strongly recommended as a supplementary edition in academic programs teaching nuclear science and radiochemistry, geo-environmental science, astrochemistry and material sciences. It will certainly show utility in programs embarking on studies in medical and especially forensic areas. The interesting examples presented underscoring inorganic MS renders this book useful to the generalist in the area of mass spectrometry in addition to the specialist who desires a basis of further development in this intriguing scientific area.

Reviewed by *Peter D. Frade, Ph.D., FAIC*

Applied Sonochemistry: The Uses of Power Ultrasound in Chemistry and Processing

Author:	Timothy J. Mason and John P. Lorimer
Publisher:	John Wiley & Sons, Inc.
ISBN#	3-527-30205-0
Price:	$ 125.00

Applied Sonochemistry: The Uses of Power Ultrasound in Chemistry and Processing, by Timothy J. Mason and John P. Lorimer, is a book for several audiences. Power ultrasound has been used for many years in two specific industrial areas, cleaning and plastic welding. Many of the applications depend on generation of acoustic cavitation in liquid media. This book focuses on the application of the technology. There are brief sections on the historical, theoretical and equipment of sonochemistry.

This book is divided into seven chapters. Chapter 1 entitled Introduction to Applied Ultrasonics has sections on background, sound frequency ranges, some of the current industrial uses of ultrasound and ultrasound in cleaning. Chapter 2 is entitled General Principles. The six subsections of this title cover an introduction, intensity and pressure amplitude, sound absorption, bubble formation and the factors affection cavitation threshold, motion of the bubble in the applied acoustic field and a summary section. The summary sections covers frequency, solvent, temperature, gas type and content, external applied pressure, and intensity. For this chapter there are 6 Appendices and an operational computer program. Chapter 3 is entitled Synthesis. The synthesis chapter subsections are The Various Sites for Sonochemical Reactions, An Attempt to Define the Laws of Sonochemistry, Homogeneous Reactions, Heterogeneous Sonochemistry, Sonochemical Preparation of Ultrafine Powders and Nanostructured Materials. Chapter 4 is entitled Sonochemistry in Environmental Protection and Remediation. The subsections include an introduction, water purification, biological decontamination, sonication of water, surface decontamination, the control of air-borne contamination and the treatment of sewage sludge. Chapter 5 is entitled Polymers. The subsections include an introduction, degradation of polymers, factors affecting polymer degradation, degradation mechanisms, polymer synthesis, and ultrasonic processing of polymers. Chapter 6 is entitled Sonoelectrochemistry. The subsections include an introduction, electrolytic discharge, electroplating in the presence of ultrasound, sonoelectroorganic synthesis and a summary. Chapter 7 is entitled Ultrasonic Equipment and Chemical Reactor Design. The subsections include methods for the generation of power ultrasound, ultrasonic apparatus, and large-scale applications. Each chapter has a list of references for that chapter. The book has a subject index and is 303 pages in length.

Reviewed by *Anne T. Sherren, Ph.D., FAIC*

The Art of Chemistry

Author:	Arthur Greenberg
Publisher:	John Wiley & Sons, Inc
ISBN:	0-471-07180-3
Price:	$59.95

The Art of Chemistry (subtitle: Myths, Medicines, and Materials) is a collection of photographs related to the history of chemistry, and accompanying narrative (70 “essays” in eight “sections”) plus Epilogue consisting of 2 essays. Although the book is supposed to be cloth-bound, my copy was precariously held together with a clear plastic front cover and a soft back cover. Whether a result of haste or a nonconformist author, the book is unusual in many other respects: The number of pages (xv+345) is approximate and pagination is arbitrary (some pages are unnumbered, others missing), e.g. page 43 is followed by an unnumbered page and then by page 46. All figures are in black and white, and the claimed “16 full-color plates”, I could not find. Though written in prose, the author used poetic license extensively. The “Contents” listing the “sections” and “essays”, gives as page number 00 in all cases.

In spite of these imperfections, the book is highly entertaining and informative. We are told that *Margarita Philosophica*, published in 1503, is the first modern encyclopedia of any importance, and was printed less than fifty years after Johannes Gutenberg printed his first books in 1455. The *Margarita Philosophica* (Philosophical Pearls) reflects the university curriculum at the end of the fifteenth century, and it covers: grammar, logic, rhetoric, mathematical topics, astronomy, music, childbirth, astrology, and hell (yes, hell).

Figures in *The Art of Chemistry* include:

- Mundus Subterraneus
- ßασιλίσκος (the basilisk or cockatrice)
- Liber de arte destillandi (book on the art of distillation)
- Coelum Philosophorum (heaven of the philosophers)
- A Compendious Body of Chymistry (by Le Févre)
- La Chymie Charitable et Facile, en Faveur de Dames
- (written by the feminine hand of Marie Meurtrac)

Figures 11b, 11c, and 12a-d are depictions of gods and goddesses in triumphal chariots heralding the six ancient metals besides gold: Venus (copper), Jupiter (tin), Saturn (lead), Mercury, Luna (silver), and Mars (iron).

On page 18 we find a sixteenth century recipe for “Le Toothpaste”:

Take blood of Dragon and Cinnamon three ounces, calcined alum two ounces; reduce all to a very fine powder, and polish your teeth twice each day.

Liber Mineralium Alberti Magni – we are informed – deals:
"De metallorum origine et inventione, generatione…….colore…..virtute, transmutatione"

In Chaucerian English (p. 22) an alchemist announces he will transform mercury (a base metal) to silver (a noble metal):

For here shul ye se by experience,
That this quicksilver I wol mortifye
Right in your sight anon withouten lye,
And make it as good Sylver and as fine,
As there is any in your purse or myne.

The Epilogue, the author admits, consists of two brief, more personal essays. One is about a friend from adolescent years, a quirky and ingenious butterfly collector and mischief-maker, who became a world renown entomology professor at Harvard. The second is a brief essay whimsically visiting the author's own chemistry genealogy, and insists that these may appear to be exercises in self-indulgence and self-aggrandizement, but they are not meant to be.
This book is not intended as a refresher of your knowledge of Greek or Roman mythology, medieval Latin, or Old English; but reading this book may give you cause to brag about your knowledge of these subjects, or make you feel deficient, as the case may be.
Reviewed by *Spyros A. Lazaris, Ph.D., FAIC*

Catalysts for Fine Chemical Synthesis, Volume 1 Hydrolysis, Oxidation and Reduction

Editors: Stan M. Roberts and Geraldine Poignant
Publisher: John Wiley & Sons, Ltd
ISBN: 0-471-62381-4
Price: $149.95

Hydrolysis, Oxidation and Reduction constitutes Volume 1 in the Series: *Catalysts for Fine Chemical Synthesis*, with Volumes 2 and 3 being in the planning stage.

In this volume frequent reference is made to *Preparative Biotransformations* (Wiley-VCH, 1999), a collection of protocols, detailing the use of biotransformations in synthetic organic chemistry. Since the early 1990s biotransformations have become accepted as powerful methodologies in synthetic organic chemistry, and the purpose of this volume is "to cover the panoply of catalytic methods available to the synthetic chemist, incorporating biocatalytic procedures where appropriate".

For the "newcomer", Chapter 1 (The Integration of Biotransformations into the Catalytic Portfolio) is a brief but excellent introduction to the use of purified enzymes or whole cells as biocatalysts covering: hydrolysis of esters, amides, nitriles, and oxiranes reduction reactions oxidative transformations carbon-carbon bond forming reactions Part II, consisting of chapters 2-12 describes "procedures"; while the crowning Chapter 13 discusses "Employment of Catalysts Working in Tandem", a one-pot sequential asymmetric hydrogenation utilizing Rh(I) and Ru(II) – catalysts, and other tandem procedures.

The following is only a sampling of microorganisms (enzymes) used in biotransformations: Acinetobacter sp., Baker's yeast (for asymmetric reduction), Baeyer-Villiger monooxygenases, Beauvaria sulfurescens (epoxide hydroxylase), Brevibacterium sp., Burkholderia cepacia (lipase), Caldariomyces fumago, Candida Antarctica (lipase), Comamonas acidovorans, Cunninghamella echinulata, Culvularia lunata, Cytochrome P450, D-threonine aldolase, Escherichia coli, Galactosyl transferase, Lactobacillus sp, Mucor sp., Pichla fasinosa, pig liver esterase, porcine pancreatic lipase, Rhizopus sp., Saccharomyces sp., Lithreonine aldolase, Xanthomonas oryzae, etc. Some enzymes, e.g. sydroxynitrile lyase (from Hevea brasiliensis) have been cloned and overexpressed.

Chapters 2, 3, 4, 5, and 6 present an overview and a comparison between various existing strategies for asymmetric epoxidation of unfunctionalized alkenes, α, β-unsaturated ketones and allylic alcohols. Chapter 7 discusses asymmetric dihydroxylation and aminohydroxylation. Chapter 8 discusses asymmetric sulfoxidation. Chapter 9 deals with asymmetric reduction of ketones using organometallic catalysts. Chapter 10 is on asymmetric reduction of ketones using Baker's yeast. Chapter 11 covers asymmetric reduction of ketones using non-metallic catalysts (oxazaborolidine borane reduction of acetophenone, asymmetric reduction of bromoketone catalyzed by cis-aminoindanol oxazaborolidine, etc). Chapter 12 presents asymmetric hydrogenation of carbon-carbon double bonds with organometallic catalysts.

In Part II of the book titled "Procedures" you find detailed expositions of reaction procedures, eg: Title: 5.2.3 Epoxidation of [E]-2-hexen-1-ol structural formulas of starting material and product, and conditions; Materials and equipment; Procedure-step by step; Table of related alcohols with yield %, ee% (configuration) upon epoxidation; Conclusion; and References

While biocatalysts may only provide viable and reliable methods in about 5-10% of all transformations of interest to synthetic organic chemists, in some cases the biotransformation will provide the key step in the best method in going from a cheap substrate to a high value, optically active fine chemical: Acylase from E.coli is used to cleave the side chain amide function of fermented penicillins to provide 6-aminopenicilloic acid en route to semisynthetic penicillins; also, hydroxylation of aromatic compounds using microorganisms is used to prepare 6-hydroxyisoniootinic acid and (R)-2-(4-hydro xyphenoxy) propanoic acid, important intermediates to pesticides and herbicides respectively.

This volume, in conjunction with the more specific references given, should be of great value to synthetic organic chemists, especially those contemplating to exploit the advantages of incorporation biotransformations into their synthetic work.

Reviewed by ***Spyros A. Lazaris, Ph.D., FAIC***

Chemical Process Technology

Author:	Jacob A. Moulijn
Publisher:	John Wiley & Sons
ISBN:	0-471-63062-4

Books on chemical processes and process technologies have become rare due to the fact that most chemical engineering departments no longer teach this course. It was good to read a new book on Chemical Technology. This book deals with some typical traditional chemical process technologies with additional applications to processes in biotechnology. It is a welcome addition to books on chemical technology.

The book consists of 13 Chapters divided among petrochemical, synthesis gas and chemicals from synthesis gas, inorganic chemicals, homogeneous and heterogeneous catalysis, fine chemicals, biotechnology, and process development. One chapter is devoted to the production of polyethylene.

Chapters 1 and 2 discuss general issues pertaining to chemical industries and give a general idea of what to expect in the late chapters. These are important and individual instructors can build their own presentations around these questions and ideas. For instance one can update the figures for energy consumption as it is known that the world energy consumption from 1990 to 2020 would nearly double {International Energy Outlook, 2000. Energy Information Agency (EIA), [Report#: DOE/EIA-0484 (2000)]}.

Chapter 3 gives a general outline of a number of processes in crude oil refining. The authors have blended process technology, chemistry and thermodynamics in an elegant manner. The flow diagrams in this and other chapters will be very useful in a design course. Caution has to be exercised on certain items such as MTBE. EPA in 1999 has recommended that MTBE be reduced because of its toxic effect on human health. Thus the shortage of isobutene mentioned on P. 92 might not be relevant with the decreased production of MTBE.

Chapters 4 and 5 are well thought out and well written. The chapters cover topics from fundamental thermodynamic concepts to reaction rates and mechanism to practical aspects of steam cracking in Chapter 4 and the production of synthesis gas in Chapter 5.

Chapters 6 and 7 deal with bulk inorganic chemicals: ammonia, urea, sulfuric and nitric acids. In addition to these inorganic chemicals, Chapter 6 includes processes for methanol production. The authors have dealt with homogeneous and heterogeneous catalysis in Chapters 8 and 9. Processes in these chapters could have been included in other chapters as the titles of the chapters are misleading, as this is not a book on catalysis. These chapters do not contain characterization of catalysts, Langmuir-Hinshelwood (who mention this mechanism on pp. 284, 293) or other rate laws, and other topics normally found in books on catalysis. In spite of this criticism, the processes described are good examples of catalytic processes.

Chapters 10 and 12 describe the manufacturing of important fine chemicals and biochemicals. The authors describe novel methods used in industry and include some important considerations of batch reactors. In these chapters, the authors describe novel developments in reactor technology. Chapter 11 is devoted to the production of polyethylene, and Chapter 13 focuses on process development.

References at the end of each chapter are adequate but should be supplemented with journal references.

Overall, this is a welcome addition to books on chemical technology. This is a valuable book for students and practicing chemical engineers.
Reviewed by *Dabir S. Viswanath, Ph.D., FAIC*

Electrochemistry in Nonaqueous Solutions

Author:	Kosuke Izutsu
Publisher:	John Wiley & Sons, Inc.
ISBN#	3-527-30516-5
Price of Book:	$110.00

Electrochemistry in Nonaqueous Solutions by Kosuke Izutsu is a book for both the person new to elctrochemistry in nonaqueous solutions and those with experience in the field. The book should prove useful to both the user and the specialist. The differences between electrochemical measurements in non-aqueous systems and those in aqueous systems are identified. Attention is paid to the hazardous and toxic properties of the solvents. A large number of tables are presented in appropriate places. The author focuses on the chemical information derived and the applications of the various electrochemical techniques. Applications are provided for both physicochemical processes and analytical methods.

This book is divided into two sections with twelve chapters. The first section covers the fundamentals of chemistry in non-aqueous solution as applied to electrochemical aspects. There are four chapters in this section. Chapter 1 is entitled "Properties of Solvents and Solvent Classification". Chapter 2 is entitled "Solvation and Complex Formation of Ions and Behavior of Electrolytes". Chapter 3 is entitled "Acid-base Reactions in Non-Aqueous Solvents". Chapter 4 is entitled "Redox Reactions in Non-aqueous Solvents". Section 2 is entitled "Electrochemical Techniques and Their Applications in Non-Aqueous Solutions". Chapter 5 is entitled "Overview of Electrochemical Techniques". Chapter 6 is entitled "Potentiometry in Non-Aqueous Solutions". Chapter 7 is entitled "Conductimetry in Non-Aqueous Solutions". Chapter 8 is entitled "Polarography and Voltammetry in Non-Aqueous Solutions". Chapter 9 is entitled "Other Electrochemical Techniques in Non-Aqueous Solutions". Chapter 9 includes electrolytic and coulometric techniques as well as the combination of electrochemical and nonelectrochemical techniques. Chapter 10 is entitled "Purification of Solvents and Tests for Impurities". Chapter 11 is entitled "Selection and Preparation of Supporting Electrolytes". Chapter 12 is entitled "Use of Non-Aqueous Solutions in Modern Electrochemical Technologies".

Each chapter has a reference section at the end of the chapter. The book has a subject index and is 346 pages in length.
Reviewed by *Anne T. Sherren, Ph.D., FAIC*

Handbook of Chemical and Environmental Engineering Calculations

Author	Joseph P. Reynolds, John S. Jeris, Louis Theodore
Publisher	John Wiley & Sons
ISBN	0-471-40228-1
Price	$150.00

The authors describe the intent of this book as "a calculations handbook that could be used as a self-teaching aid." That is an interesting and useful approach to the diverse background required in environmental engineering, but it has not been fully realized in this volume. The book delivers the promise of a well-indexed reference to useful calculations across the gamut of disciplines used in the environmental sciences.

A structure is provided in the chapter topics and layout that progresses from the fundamentals through the most common applications, ending up with a collection of peripheral topics that are normally scattered across a wide range of texts. This organization and availability of information, examples, and worked problems is indispensable for the practicing environmental technologist. Most of the topics are covered much better in specific courses, and will be used primarily for a review by those trained in those topics. However, the access to relevant calculations and applications in many peripheral areas, which are poorly covered in traditional engineering course work, are particularly valuable. Professionals who have migrated into different job responsibilities will find this reference an immediate asset in their daily work.

As a novel form of textbook, this book is unimpressive, lacking the pedagogy necessary to really understand the engineering topics. It may be too expensive as a stand-alone reference for students in addition to other textbooks. But it is ideally written and useful for working professionals, and may also be valuable to senior level students who are exploring the range of options in environmental engineering. It is not a replacement for specialized discipline texts, but it is an extremely helpful adjunct to a professional engineering library.
Reviewed by *Steven J. Cooke, MChE, FAIC*

Heterocyclic Chemistry
Author M. Sainsbury
Publisher: John Wiley & Sons, Inc.
ISBN: 0-471-28164-6
Price: $34.95

Heterocyclic Chemistry is one of the books in the *Basic Concepts in Chemistry* series. This series of books consists of short, single-topic or modular texts, concentrating on the fundamental areas of chemistry taught in undergraduate science courses. Each book "provides" a concise account of the basic principles underlying a given subject, embodying an independent-learning philosophy and including worked examples.

Preface, Contents, Answers to Problems, and Subject Index follow in that order.

The focus in this book is on the more common four-, five-, and six-membered systems containing one hetero atom (N,O, or S), and little attempt is made to extend the coverage to more complex heterocycles.

Chapter 1 (Introduction to Heterocyclic Chemistry) is, as the title implies, a general one, and covers: Aims, Nomenclature, Importance of Heterocyclic Compounds to Life and Industry, General Principles (aromaticity, non-aromaticity, and anti-aromaticity, ring strain in cycloalkanes and their heterocyclic counterparts), Worked Problems, Summary of Key Points, Problems, References, and Further Reading. The remaining seven chapters are more specific, e.g. Chapter 2 is on Pyridine, while Chapter 7 discusses Benzo [b]-pyrrole, -furan, -thiophene, and again the approach, with some variations, is similar: Aims, Introduction, Reactions, Synthesis, Important Derivatives, Worked Problems, Summary of Key Points, Problems, Further Reading.

The level of discussion ranges from introductory to intermediate, and though the treatment is not comprehensive, it is "solid" and not as deceptively plain as one might surmise from the size of the book (vi+142 pages); for example, Named Reactions discussed include: Bischler-Napieraliski, Chichibabin, Leimgruber-Batcho, Mannich and Vilsmeier; Named-synthese include: Conrad-Limpach-Knorr, Fisher Indole, Friedländer, Guareschi, Hantzsch, Knorr, Paal-Knorr, Pictet-Spengler, Pomeranz-Fristsch, and Wender Indole; Worked Problems include Problem 9.2: Provide a synthesis of stilbazole (structure given) from 2-Methylpyridine; Problem 3.1: Provide a synthesis of 1-benzyl-1,2,3,4-tetrahydroquinoline from quinoline; or suggest a synthesis of chelidonic acid (structure given) from diethyl oxalate and acetone. Structures of compounds included in the text are, among others, the foul-smelling skatole, the Tyrian purple (used to dye the robes of Roman emperors), strychnine (a poison of detective novel fame), Paraquat (an herbicide interfering with photosynthesis), Nifedipine (a cardiovascular drug), etc.

Although primarily an undergraduate text, the main principles that govern heterocyclic chemistry as a whole are addressed in this book, providing a sure foundation for those wishing to widen their interest in heterocyclic chemistry in later years.
Reviewed by *Spyros A. Lazaris, Ph.D., FAIC*

Human and Ecological Risk Assessment Theory and Practice

Edited by:	Dennis J. Paustenbach
Publisher:	John C. Wiley and Sons, Inc.
ISBN:	0-471-14747-8
Price:	Unknown

Human and Ecological Risk Assessment Theory and Practice is divided into 3 sections: Theory (Chapters 1-6); Human Risk Assessment and Ecology Risk Assessment Case Studies (Chapters 7-24); and Life Cycle, Cost Benefit, Risk Communications, and Evolving Issues (Chapters 25-32). There are 63 contributors. Multiple references are listed after each chapter. Reilly's forward presents eight valuable lessons from the real world of risk assessment.

The premise of the theory and practice is that "A health risk assessment is a written document wherein all pertinent scientific information, regarding toxicology, human experience, environmental fate, and exposures, are assembled, critiqued, and interpreted." Whereas "Risk management is the process of evaluating alternative regulatory actions and selecting among them." This book clearly shows that different agencies use differing characterization of risk and varied methodologies for risk assessment. The book clearly defines and illustrates the four steps of the assessment process through case studies: Hazard Identification, Dose-Response Assessment, Exposure Assessment, and Risk Characterization. The case studies also demonstrate the application of statistical models and probabilistic analysis including Relative Risk Regression, Poisson Regression, Quantal-Response, Time-to-Response, Armistage-Doll Response, Benchmark Dose, uncertainty/safety factor, physiologically based pharmacokinetic (PBPK), Biologically Based Disposition, Two-Dimensional Uncertainty Analysis, Two-Stage Clonal Expansion (TSCE), and Monte Carlo Analysis. The text indicates when each of these methodologies is appropriate and calls out when bias can be introduced into a study.

Whether the reader is new to risk assessment or has experience conducting a risk assessment, the case studies presented in this book provide valuable examples of thorough assessments that present a variety of ways to assess and get the same result. The discussion shows that there is a need to understand the dose to the majority of the adult population and how dose response differs in children.

A broad analysis of risk assessments for contaminated water, contaminated soils, exposures to air contaminants, evaluation of occupational hazards, risk to foods, risk associated with consumer products, and risk to birds is presented. Chemicals evaluated in case studies are PAH (polycyclic aromatic hydrocarbons), benzene, radon, LET (linear energy transfer) radiation, refractory ceramic fibers, dioxin, chlordane, TCDD, methylene chloride, vinyl chloride, food-borne pathogens, hexavalent chromium, trivalent chromium, inorganic arsenic, beryllium, cobalt, lead, manganese, nickel, selenium, organophosphorus pesticides, isofenphos, parathion, iodine-131, cesium-137, radioactive lanthanum, uranium, elemental mercury, PCBs, DDT, natural rubber latex, cadmium, zinc, lead, chlorpyrifos, carbaryl, and deltamethrin. Animal, plant, insect, and water toxicity case studies are also presented as well as a case study of comparative EIO-LCA steel versus reinforced concrete in bridges.

Evolving issues include children's health including developmental defects, childhood cancer, and childhood asthma as well as biomarkers, chemical mixtures, POPs (persistent organic pollutants), and genetically modified foods.

Human and Ecological Risk Assessment Theory and Practice is an excellent reference volume on health risk assessment for toxicologists, industrial hygienists, environmentalists, chemists, pol-

icy analysts, and graduate students. Additions to the first edition include more ecological and evolving issues and chapters on life cycle analysis and cost benefit analysis.
Reviewed by *Helen Wythe, Ph.D., FAIC*

Introduction to Environmental Analysis

Author: Roger Reeve
Publisher: John Wiley & Sons
ISBN: 0-471-49295-7
Price: $45.00

This book, one of the Analytical Techniques in the Sciences series of texts, is targeted at undergraduate students or professionals who possess a basic knowledge of instrumentation and a desire to learn the basics of environmental analysis. The book includes a series of discussion and self-assessment questions, which allow the reader to focus on the topic being presented. The questions also provide the reader with an opportunity to evaluate his/her knowledge and insight relative to the problems and issues being discussed.

This book contains background information on general environmental contamination, why problems exist, issues related to monitoring environmental contamination, and problems surrounding the regulation of industrial discharge. The background information is an accurate overview of the current environmental landscape. The information that addressed the concept of bioaccumulation as part of the overall environmental pollution concern was especially well presented.

One chapter discusses contaminant transportation in the environment, development of sample collection schemes, sample collection techniques, and sample storage; a well-presented insight into the challenge associated with planning and execution of sample collection events that accurately define the extent of contamination at a site is provided. Descriptions of some sample collection techniques provide the reader with a good representation of the issues surrounding representative sample collection. Good information is provided on the basic concepts behind the determination of where to collect samples and how to preserve the samples once they have been collected.

Several chapters are dedicated to the analysis of air, water, solid, and biological samples for organic compounds, inorganic elements, general chemical properties, and physical characteristics. The descriptions of the analytical techniques provide general information about how the instruments function. In addition, advantages, disadvantages, and limitations of the analytical techniques are touched upon in the descriptions.

The reader would be disappointed if he/she were looking for a detailed explanation of instrumental techniques or an encompassing reference of environmental sample collection and analytical techniques. In conjunction with a training course for basic field sample collection and laboratory analytical techniques; however, this text offers all that an instructor or student would desire to have in a text. This book is a good reference for environmental professionals because the entire environmental project process from planning through analysis is presented with enough detail to inform but not so much detail that the reader is overwhelmed.
Reviewed by *Stephen T. Zeiner, CPC, MAIC*

LC/MS Applications in Drug Development

Editor: Mike S. Lee
Publisher: Wiley-Interscience
ISBN# 0-471-40520-5
Price: Unknown

Over the past decade, LC/MS has become widely accepted as an integral part in the drug development process. As one of the *Wiley-Interscience Series on Mass Spectrometry* (Series Editors, Dominic M. Desiderio and Nico M. M. Nibbering), this book focuses on the roles of LC/MS in the pharmaceutical industry and provides perspectives on the significant changes in strategies for pharmaceutical analysis. Using selected examples, this book highlights unique advantages of LC/MS and the interrelation between the drug development activities that generate samples and the activities responsible for analysis. Future application of LC/MS for accelerated drug development and industry trends that deal with sample preparation, chromatography, mass spectrometry, and information management are also discussed.

The book is comprised of five chapters. Chapter 1 contains a general introduction on the current challenges on analytical needs in pharmaceutical industry and how the LC/MS techniques are integrated into the drug development process. A brief history of LC/MS is also presented.

Chapter 2 offers an overview of the drug development process. The four stages of drug development (drug discovery, preclinical, clinical, and manufacturing) are discussed which provides a good introduction to readers who are new to pharmaceutical industry.

Chapter 3 illustrates the accelerated drug development strategies based on both quantitative and qualitative process pipelines. Several models (FTE, sample throughput, elimination, and rate-determining event) are discussed in related to opportunities for accelerated development.

Chapter 4 and chapter 5 provide a brief review of the LC/MS development process. It also reviewed nine strategies consistently used in drug development process: standard methods, template structure identification, databases, screening, integration, miniaturization, parallel processing, visualization, and automation.

Chapter 6, the major chapter of the book, is devoted to LC/MS applications. The applications are organized according to general drug development cycles (i.e., drug discovery, preclinical development, clinical development, and manufacturing) to provide a "big picture" for a wide community of scientists. This sequential arrangement provides a unique perspective on the contributions of LC/MS technique in drug development.

The last three chapters, all of them are fairly short, provide the perspectives and personal thoughts on the future direction of LC/MS applications in the pharmaceutical industry. Readers might find less redundancy if the author could combine the three chapters into one.

Overall, the book provides enough information for reader to understand pharmaceutical LC/MS applications as well as drug development process. A book covering such a field of almost explosive growth and applications must by necessity be brief. But readers should have no difficulty to find additional information from a list of up-to-data references included at the end of the book. This book is useful not only for students and scholars of analytical chemistry, but also for managers and other scientists working in pharmaceutical industry. As another fine addition to the *Wiley-Interscience Series on Mass Spectrometry*, it should be in the collections of all research libraries.

Reviewed by *Yushen Guo, Ph.D., FAIC*

Molecular Modeling of Inorganic Compounds, Second Edition

Author:	Peter Comba and Trevor W. Hambley
Publisher:	John Wiley & Sons, Inc.
ISBN#	3-527-29915-7
Price:	$145.00

Molecular Modeling of Inorganic Compounds, Second Edition by Peter Comba and Trevor W. Hambley is a book for several audiences. Molecular mechanical modeling of chemical compounds has been developing for the past 30 years. This book discusses the recent developments that permit the modeling of larger inorganic compounds. Initially molecular modeling of inorganic compounds was limited to small molecules and simple coordination complexes. Recent developments permit the extension of this field to include organometallic compounds, catalysis and the interaction of metal ions with biological macromolecules. The number of different metals and the variety of coordination numbers, coordination modes, geometries and electronic states they can adopt, complicate the application of molecular mechanics to coordination compounds. For this reason the existing models used for metal containing compounds are more complex than those available for organic molecules. Only a few of the commercially available packages are able to reliably deal with even a small subset of the possible metal-based systems. The goals of this book are to provide an understanding of molecular mechanics, to show that it can be applied successfully to a wide variety of inorganic compounds. This book is divided into three parts. Part 1 is the theory section. The theory section includes an introduction to molecular modeling and the historical background. Various molecular modeling methods are briefly discussed. The parameterization, approximations and limitations of molecular mechanics are presented. Computation and multiple mimima problems are also included. Section 2 includes 9 chapters related to applications. The authors have attempted to give a wide-ranging coverage of all the areas of interest to inorganic chemists. However, in each chapter, the authors selected the most instructive studies and these are discussed in detail. The aim is to show the types of problems and to indicate the directions being taken to avoid the existing limitations. The topics include structural aspects, and steroselectivities, metal ion selectivity. Spectroscopy, electron transfer, electronic effects, bioinorganic chemistry, organometallics, and compounds with s-, p- and f-block elements. Part 3 is the practice of molecular mechanics. One chapter effectively discusses the model, the rules and the pitfalls. The next chapter is a tutorial with 20 exercises. Included in the tutorial are very clear specific directions for building the model with Hyperchem. The tutorials include both icons and screens for the various steps. The tutorial uses Hyperchem to build the models and MOMEC to do the computations. There are four appendices divided into a glossary, fundamental constants, units and conversion factors, software and force fields, and books on molecular modeling and reviews on inorganic molecular modeling. The list of references is long and there is also an index. This book includes a CD Disk for the tutorial and software needed.

Reviewed by *Anne T. Sherren, Ph.D., FAIC*

1,3-Dipolar Cycloaddition

Editors:	Albert Padwa and William H. Pearson
Publisher:	John Wiley & Sons, Inc.
ISBN:	0-471-38726-6
Price:	$425.00

This book whose full title is: *Synthetic Applications of 1,3-Dipolar Cycloaddition Chemistry toward Heterocycles and Natural Products*, constitutes volume 59 in *The Chemistry of Heterocyclic Compounds* series. This series, which started in 1950, attempts to make the extraordinarily complex and diverse field of heterocyclic chemistry as organized and readily accessible as possible.

The chemistry and applications to synthesis of 1,3-dipolar cycloaddition reactions in the broad context of organic chemistry were first covered in a widely cited two-volume treatise edited by Prof. Albert Padwa and appeared in 1984. Since then, substantial gains in the synthetic aspects of this chemistry have dominated the area, including both methodology development and a body of creative and conceptually new applications of these [3+2]-cycloadditions in organic synthesis. The heteroatom-containing cycloadducts may be transformed into a variety of other functionalized organic molecules, whether cyclic or acyclic. In recent years, numerous natural and unnatural products have been prepared by synthetic routes that have 1,3-dipolar cycloaddition as a critical step in their synthesis.

The 12 chapters of the book were written by sole or dual authors from the USA, the UK, and a scattering from other countries (Germany, Japan, Denmark, Switzerland, Poland, Argentina, and Taiwan).

Nitrones (Chapt 1) are most useful through their ability to generate N- and O-based functionality from cycloadducts as well as the potential to introduce multiple chiral centers stereochemically.

Silyl and alkyl nitronates (Chapt 2) are discussed from the point of view of structure, preparation, physical, chemical and spectroscopic properties, and the mechanistic aspects of the dipolar cycloaddition.

Azomethine Ylides (Chapt 3) are discussed from the point of view of their generation using silicon-based protocols or alternative generation procedures, asymmetric reactions, intramolecular cycloadditions, and metal-mediated reactions.

Carbonyl Ylides (Chapt 4) in tandem with subsequent cycloaddition reactions present a highly efficient regio- and stereospecific way of approaching many synthetic problems.

Thiocarbonyl Ylides (Chapt 5) have been recognized as valuable synthetic intermediates for 1,3-dipolar cycloaddition chemistry.

Chapter 6 describes some recent advances in the generation and use of Nitrile Oxides as 1,3-dipoles as well as progress in rationalizing the reactivity and stereoselectivity of their cycloadditions.

With Nitrile Ylides and Nitrile Imines (Chapt 7), the major development of new chemistry has been the extensive exploration of intramolecular reactions both in cycloaddition chemistry and in electrocyclization of 1,3-dipoles with extended conjugation.

Diazoalkanes (Chapt 8), Azides (Chapt 9) and Mesoionic Ring Systems (Chapt 10) are followed by more general topics: Effect of External Reagents (Chapt 11) and Asymmetric Reactions (Chapt 12).

A sampling of products to which 1,3-dipolar cycloaddition can lead includes: antimalocrial alkaloids, adamantane-spirothiazolines, quinocarcin, triquinane sesquiterpenes, heterocyclic dendrimers, epi-hippodamine, zaragozic acids, epothilones A and B, phyllanthocin, papuamine, and carzinophilin, to mention just a few. "Protocols" discussed include: Ditami, Hashimoto, Hodgson, Houk-Jäger, Padwa, Kanemasa, Merck, etc. A non-chemist who casually opens this book may become curious and want to read more about: facial selectivity, caged compounds, PM3 calculations, WIN inhibitor, Evan's auxiliary, 5 or 6-exo-dig process, one-pot procedures, Oppolzer's sultan, push-pull ylides, or LUMO.

Printing errors are very rare, almost unnoticeable, and no more serious than desilyation (p. 170) instead of desilylation. For those in the field, this is an excellent reference.
Reviewed by *Spyros A. Lazaris, Ph.D., FAIC*

Organometallics in Synthesis: A Manual 2nd Edition

Editor:	Manfred Schlosser
Publisher:	John Wiley & Sons, Ltd
ISBN:	0-471-98416-7
Price:	$149.50

This voluminous (x+1243 pages) book is an updated ('02) and greatly enlarged edition of its precursor that appeared in 1994. Users of the 1st Edition will notice that four additional chapters have been added featuring the chemistry of tin, zinc, zirconium, chromium, and iron. Previous chapters have been extensively reworked and updated; for example the number of Tables to be found in the chapter covering alkali and alkali-earth reagents has increased from 12 to 166.

The Manual offers guidance in the form of countless schemes, tables, and detailed experimental procedures (substrate, reagents, temperature, yield, and ee where applicable) and protocols along with recommendations on associated equipment needs as well as practical advice at critical stages. Indispensable mechanistic insight is provided, which is crucial to those who wish to apply these existing tools rationally and to contribute to the further development of novel reagents and methodology. All contributions are written with practical laboratory work in mind, "be it for undergraduate and graduate students learning the trade, or for the experienced industrial synthetic chemist expanding his/her repertoire of additional versatile reagents and catalysts."

Organoalkali Chemistry, contributed by Manfred Schlosser (Univ. of Lausanne), takes up approximately one third of the book; it is a treasure trove of facts and information with an astounding 2,100 references to the original literature.

Organotin Chemistry, by James Marshall (Univ. of Virginia), discusses preparation and reactions of tetraalkyltin compounds, stannates (acyl-, vinyl-, allylic-, allenic, etc.), and also palladium-catalyzed coupling of organostannates (stille couplings) in over 100 pages (176 references).

Organoboron Chemistry, by Keith Smith (Univ. of Wales), covers inter alia safety, handling, reproducibility and selection of reactions and reagents (70 pages, 175 references).

Organoaluminum Chemistry was written by Hisashi Yamamoto (Nagoya Univ.) and covers related chemistry and topics such as the "Ate complex and its reactivity" and specialized topics (Ziegler-Natta and related complexation chemistry) in 40 pages and 72 references.

Organozinc Chemistry, by Eiichi Nakamura (Univ. of Tokyo), discusses structures, reactivity, and preparation of organozinc compounds, addition to C-O, C-N, C-C double/ multiple bond, the Simmons-Smith reaction, and substitution at carbon by organozinc reagents (70 pages, 193 references).

Organocopper Chemistry, contributed by Bruce H. Lipshutz (Univ. of California), discusses copper complexes derived from organolithium and Grignard reagents, by transmetallation and miscellaneous copper reagents (140 pages, 256 references).

Organotitanium Chemistry was written by Manfred T. Reetz (Max-Plank-Institut) who puts special emphasis on the use of titanium (IV) in C-C bond formation, especially on the titanation of classical carbanions of C-H-acidic compounds, which generates selective reagents for Grignard, aldol, and Michael additions, and substitution reactions (90 pages, 462 references). It took a "titanic" effort to assemble all this material.

Ei-ichi Negishi (Purdue Univ.) gave us *Organozirconium Chemistry*, systematically discussing the preparation of organozirconium compounds and their reactions of systemic utility, especially zirconocene and related derivatives (130 pages, 225 references).

Martin F. Semmelthack of Princeton University is the author of *Organoiron and Organochromium Chemistry*, discussing each type of complex including preparation and handling, then the mechanism and associated aspects of the scope and limitations, and finally specific applications with detailed procedures (120 pages, 300 references).

Organopalladium Chemistry by Louis F. Hegedus (Colorado State Univ.) is the crowning chapter of the book. Palladium complexes, we are told, have a very rich chemistry and are among the most readily available, easily prepared and easily handled of transition metal complexes, and promote a very wide range of organic transformations.

All the contributing authors are experts in their respective fields to which they contributed. In this collection of chapters, they have distilled and condensed all pertinent knowledge on organometallic use in synthetic organic chemistry. This is a very useful and practical compendium indeed.

Reviewed by *Spyros A. Lazaris, Ph.D., FAIC*

Polymer Blends

Editor:	D. R. Paul, C. B. Bucknall
Publisher:	John Wiley & Sons, Inc.
ISBN#	0-471-24825-8
Price:	Unknown

This two-volume set on polymer blends summarizes both the science base and the progress in the technological developments and the commercial applications. Through contributions from near sixty highly respected experts from around the world, this book offers a coherent presentation on this subject while the style and content of each chapter are coordinated to ensure a smooth and sensible transition from topic to topic. Each chapter provides enough background information without sacrificing the most important issues critically gleaned from the literatures, which makes this book useful for both the beginners as well as the experts.

Volume1 is devoted to the formulation aspect of polymer blends. It contains mainly the physics, chemistry, and processing issues associated with the formation of polymer blends and the evaluation and control of their structure. The chapters are organized into three well-balanced sections: thermodynamics (including seven chapters on statistical thermodynamics of polymer solution and blends, polymer-polymer interactions based on mean field approximations, hydrogen bonding systems, polymer blends as viewed by analogue calorimetry, crystalline polymer blends, blends of rigid-chain polymers, thermodynamics of polyolefin blends); characterization (including chapters on morphology characterization by microscopy techniques, viscoelastic characterization of polymer blends, optical characterization, and neutron scattering); and structure formation (formulation and characterization of thermoset-thermoplastic blends, chemical reactions in blends based on condensation polymers, morphology and properties of blends containing block copolymers, factors influencing the morphology of immisiscible polymer blends in melt processing, reactive compatibilization, and processing aids).

Volume 2 deals with the performance of polymer blends and primarily concerned with how blends perform in practical situations. This volume is divided into five sections: mechanical properties and fracture resistance (including chapters on quasielastic mechanical properties, application of fracture mechanics for characterization of toughness, characterizing toughness using standard empirical tests, deformation mechanisms in rubber-polymer interface, core-shell impact modifiers, toughening semicrystalline thermoplastics, toughening of epoxies, fatigue-crack propagation); blending for specific performance (transmission and reflection of light in multiphase media, thermomechanical performance, barrier materials by blending); reinforce blends (reinforced polymer, liquid crystalline polymer, from polymer blends to microfibrillar reinforced composites); elastomeric blends (elastomer, thermoplastic vulcanizates); and recycling of polymer blends and mixtures.

Overall, this set of books covers a broad range of theoretical and experimental discussions and provides an authoritative resource on the structure-property relationships for polymer blends. The case studies are explained well and the introductory material is concise. A complete reference list follows and enriches each chapter allowing the reader to use it as a starting point to carry on further researches on these topics. Both researchers and application engineers will benefit from this book. People will find this book indispensable as a reference for further developments on the subjects.

Reviewed by *Yushen Guo, Ph.D., FAIC*

Books Available for Review

For a current list of books that are available for review from the AIC National Office, please visit the website at www.TheAIC.org and click on *The Chemist* button, then the Books available for Review link. You must be a member in good standing to participate. Publishers usually sent us one copy of each book listed. Send an email to the AIC National Office with your first, second and third choices. We cannot guarantee any book. All book reviews must be submitted electronically. We will publish submitted reviews in the next issue of *The Chemist*, space be available.