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METHODS OF TEACHING THE TOPIC OF HIGH MOLECULAR COMPOUNDS ON THE BASIS OF DIFFERENTIAL APPROACH

Movlonova Sokhiba Abdikodirovna
Teacher, Department of Methods of Teaching Chemistry, Faculty of Natural science, TSPU named after Nizami, Uzbekistan

ABSTRACT

This article describes the methods of teaching the topic of high molecular compounds on the basis of differential approach at higher education institutions and university instruction. This course for advanced undergraduates and masters level graduate students focuses on teaching the basics of polymer history, synthesis and differential approaches, characterization with connections to the core chemistry curriculum in a small auditory size environment and without a textbook. Furthermore, an extensive overview of the applications of polymeric materials gives students a connection to real life applications. The course includes polymer case studies, informational lessons on real world objects made of polymers, and demonstrations. Student presentations on how polymers are important to society help connect the course to the world around them. The course is designed to instill the knowledge necessary for students to be successful in a career in polymers. A brief discussion of course reflections and student input is also given.

1.INTRODUCTION

Among the many substances found in nature, there is a group of substances that differ from others in their physical properties, which can form fibrous membranes, etc., due to the high viscosity of solutions. This group includes cellulose, lignin, pentosans, starch, proteins and nucleic acids, which are formed during the vital activity of plants and animals. A variety of fibers, leather and rubber, called natural polymers, have been used since ancient times.

High molecular weight compounds differ from lower molecular weight compounds by their extremely large molecular mass. Typically, substances with a molecular mass of 5,000 or higher, whether natural or synthetic, are classified as high-molecular compounds.

This means that the chemistry of high molecular weight compounds strikes chemicals consisting of hundreds and thousands of atoms.

Analysis of high-molecular compounds has shown that their molecules are basically the same parts. Therefore, such parts are called elementary links.The elemental link in natural rubber is the isoprene molecule:

$$\begin{array}{c} CH3 \\ I \\ -CH2 - C = CH - CH2 \end{array}$$

If we dwell on, the background and role of polymers, they are materials made of long, repeating chains of molecules. The materials have unique properties, depending on the type of molecules being bonded and how they are bonded. Some polymers bend and stretch, like rubber and polyester. Others are hard and tough, like epoxies and glass. The chemist Hermann Staudinger first proposed that polymers consisted of long chains of atoms held together by covalent bonds, which he called macromolecules. Paul Flory was awarded the Nobel Prize in Chemistry in 1974 for his work on polymer random coil configurations in solution in the 1950s.

Polymers touch almost every aspect of modern life. Chances are most people have been in contact with at least one polymer-containing product — from water bottles to gadgets to tires — in the last five minutes.

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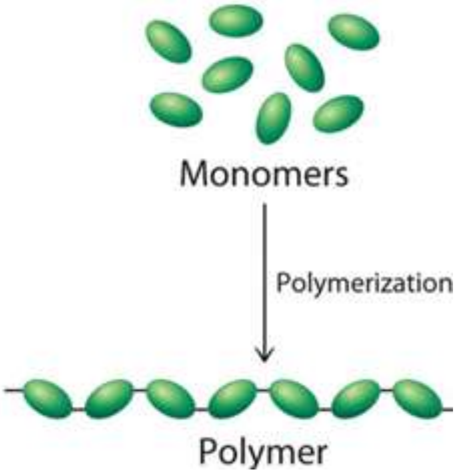
Almost, polymers are used in every area of modern living. Grocery bags, soda and water bottles, textile fibers, phones, computers, food packaging, auto parts, and toys all contain polymers. Even more-sophisticated technology uses polymers. For example, "the membranes for water desalination, carriers used in controlled drug release and biopolymers for tissue engineering all use polymers," according to the ACS.

The term polymer is often used to describe plastics, which are synthetic polymers. Popular polymers for manufacturing include polyethylene and polypropylene. Their molecules can consist of 10,000 to 200,000 monomers.



Picture 1. A polymerization reaction, a large number of monomers become connected by covalent bonds to form a single long molecule, a polymer.

In Uzbekistan several scientists have learnt high molecular compounds in chemistry speciality. They are: T.M.Babayev(“High molecular compounds”), Askarov M.A., Yoriev O.M., Yodgorov N. (“Physics and chemistry of polymers”) S.Sh.Rashidova (“Introduction to high molecular weight chemistry connections”), S.R.Rafikov (“Introduction to physico-chemical solutions of polymers) and others.

2. EXPERIMENTAL

Material and Methods

Researchers are experimenting with many different types of polymers, aiming to further medicine development and enhance products we already use. For example, carbon polymers are being developed and enhanced for the automotive industry.

"Carbon-fiber-reinforced polymer (CFRP) composites — also called carbon-fiber laminates — are the next-generation materials for making cars lighter, more fuel efficient and safer," according to a 2016 Live Science column by Nikhil Gupta, an associate professor, and Steven Zeltmann, a student researcher, both in the Composite Materials and Mechanics Laboratory of the Mechanical and Aerospace Engineering Department at New York University Tandon School of Engineering. "Carbon laminate is extremely strong and stiff because of its woven layers of nearly pure carbon fibers bonded together by a hardened plastic, such as epoxy resin."

So, this work presents following teaching methods proving to teach high molecular compounds on the basis of differential approaches. Teaching and learning is conducted through a variety of methods and is adjusted depending on the type of material being presented. Polymer synthesis methods are taught by board lecture, real life examples, auditory discussion and interactive case studies. This is a slower approach, but it often helps students solidify knowledge, have time to prepare to ask questions and better discussions. This slower pace method is especially important for students with very little or no exposure to polymers, and many of whom have no experience with radical initiated reactions and mechanisms.

This method also allows for drawing clear connections with organic chemistry. For the application part of the auditory, lectures are taught using a mix of computer aided presentations and videos from scientific research publications (Kraft, Rankin, & Arrighi, 2012). These were supplemented by pointing out important points and connections on the board to solidify concepts. The presentation videos allowed for showing the complexities and awe-inspiring nature of modern materials in a way unattainable through drawing. Most of the applications portion of the course is put together using primary literature from journals such as Macromolecules, Polymer Chemistry, Chemical Communications, JACS, Nature, and Science, etc. This allows for some of the newest and most exciting

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topics in polymer science to be presented and connected to the synthesis techniques examined in the first part of the course. The biggest challenges with using primary literature is that many of the articles are very advanced to upper level undergraduate or first year master's students, so great care must be given to clarify and connect the advanced concepts back to the basic polymer chemistry learned in the first part of the auditory. The lectures are broken up by a series of auditory and/or group activities. The first type of activity is a case study discussion (Campbell, Powers, & Zheng, 2015). This is most often a recent paper using a polymerization method discussed in auditory. The problem is presented with background, and split by either showing how the researchers solved the problem or gave the problem without a solution, in both cases using their learned knowledge to see what kind of method they could come up with. As an example, students are presented with a problem related to polymer membranes in proton exchange devices. The device structure of a proton exchange device is discussed as well as limitations with current technology. The standard polymer Nafion® is introduced and its potential limitations were determined through auditory discussion. A potential replacement is then introduced from using phosphonic acid block co-polymers made by anionic polymerization (Perrin, Elomaa, & Jannasch, 2009). A learning example is introduced showing the importance of structure in anionic polymerization, with unclerically hindered monomers undergoing nucleophilic substitution at the phosphonate instead of undergoing anionic polymerization. By adding steric bulk to the initiating monomer, polymerization proceeded. The differences in properties between Nafion and this new material are then compared and contrasted.

The second activity is the discussion of real-life applications of polymers examined in auditory.

3. RESULTS AND DISCUSSION

During the course teaching covers a wide range of topics including general polymerization techniques of basic polymer systems (i.e. polystyrene, nylon-6,6 etc.), block copolymers (structural motifs, types of blocks), conjugated polymers and their photonic and electronic properties and applications, high performance polymers (smart polymers, actuators, gels), hybrid polymers (silicones and other inorganic polymers) and biopolymers (drug delivery, tissue engineering, biodegradable, non-fouling and biomimetics). The synthesis, properties, and the industrial, biomedical and optoelectronic applications of all of these materials are discussed. Students learn design principles to achieve specific functions from polymers, synthetic methodology, structure property relationships, and fabrication of devices from polymers.

When we use experimental works, we must work in a well-ventilated laboratory and wear eye protection and disposable nitrile gloves when pulling out the thread.There are given several part of using methods of teaching the topic of high molecular compounds in order:

- Wear eye protection and disposable nitrile gloves when pulling out the thread.
- The room should be well ventilated and there must be no sources of ignition.
- Details for waste disposal can be found on ASE1, SSERC2 or CLEAPSS3 websites.
- This demonstration has been described in many sources using chlorinated solvents for the acid chloride. These are no longer considered safe and will soon become unavailable. Cyclohexane is less dense than water whereas chlorinated solvents are denser. The layers are therefore inverted compared with the old method.
- Cyclohexane is preferred to hexane as it is less harmful.
- Hexanedioyl dichloride (adipoyl chloride) can be used as an alternative to decanedioyl dichloride, but it does not keep as well.
- Decanedioyl dichloride reacts with moisture in the air to produce decanedioic acid which forms nylon much less readily than the acid chloride. Ensure that the bottle is restoppered carefully after opening and consider storing it in a desiccator. The dichloride is also available in 5 cm3 sealed ampoules. The cyclohexane solution will still make nylon for a couple of days after being made up even if left unstoppered. A solution kept in a stoppered bottle is still usable after two weeks. The solution can be stored over anhydrous sodium sulphate or calcium chloride to keep it dry.
- Solid 1,6-diaminohexane can be difficult to get out of the bottle. The easiest way to manipulate it is to heat the bottle gently in warm water until it melts at 42 °C and dispense the liquid using a dropping pipette.

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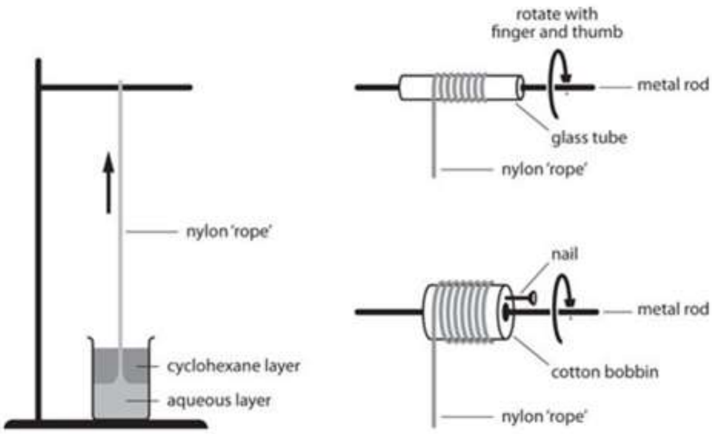

Picture 2. Process of procedure.

The reaction is a condensation polymerisation

nH2N(CH2)n6NH2+nClOC(CH2)8COCl→H2N[(CH2)6NHCO(CH2)8]nCOCl+nHCl

The nylon formed is nylon 6 –10 so called because of the lengths of the carbon chains of the monomers. Nylon 6 – 6 can be made using hexanedioyl dichloride (adipoyl chloride). The diamine is present in excess to react with the hydrogen chloride that is eliminated. An alternative procedure is to use the stoichiometric quantity of diamine dissolved in excess sodium hydroxide solution.

4. CONCLUSION

In conclusion, methods of teaching the topic of high molecular compounds on the basis of differential approach has been discussed. The approaches described would allow instructors with little or no experience in polymer chemistry to develop their own courses, and/or incorporate polymer topics into their core courses. Polymers will continue to be an important part of everyday life for many years to come (Ritter, 2002) and therefore education about their syntheses, function, and properties will only become more important.

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