Professional Development Programme on
Enriching Knowledge for the Chemistry Curriculum

Topics: The Future of Plastic

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Objectives:

1. To introduce the significance of plastic-based materials;
2. To enrich teachers' knowledge on the polymerization processes and mechanisms in producing important polymers;
3. To explain the differences in chemical structures of common plastics and how these differences define which plastics readily break down into microplastics in the ocean;
4. To discuss the current developments and implementations of plastic recycling and the use of bio-based and/or biodegradable polymers.

Abstract: Plastics are primarily comprised of polymers, along with various additives such as flame retardants and plasticizers that tune the physical properties of the materials. They are made from fossil fuels and have brought great convenience to our lives. We use plastic-based products in various fields, such as food packaging, electronics, light-weight electric vehicles, construction, and many other fields. Despite these benefits, the use of plastics is also causing major environmental challenges. Around the world, about 16 billion disposable coffee cups are consumed every year, and half a billion plastic straws are discarded every day. Most plastics are not degradable and the common schemes of plastic recycling are largely ineffective. Most single-use plastics go directly into waste and then are dumped to landfill and into oceans, which are causing significant harm to the environment and marine life. Therefore, developing environmentally friendly and biodegradable alternatives to current plastics represents an emerging need for a sustainable future. In this lecture, we will discuss how the important polymers are produced and their desirable properties, including the chain-growth polymerization, step-growth polymerization, and how the chemical structures of polymers affect their physical properties. In addition, the challenges of recycling the plastics that we use today and the current development of the use of bio-based and/or biodegradable polymers will be highlighted.

Suggested reading materials:

1. The future of plastics – C&EN – American Chemical Society (ACS), 2020. https://cen.acs.org/sections/discovery-reports/the-future-of-plastic.html
2. Science to enable sustainable plastics – The Royal Society of Chemistry (RSC), 2020 https://www.rsc.org/new-perspectives/sustainability/progressive-plastics/
3. Ting, J. M.; Ricarte, R. G.; Schneiderman, D. K.; Saba, S. A.; Jiang, Y.; Hillmyer, M. A.; Bates, F. S.; Reineke, T. M.; and Macosko, C. W. Polymer Day: Outreach Experiments for High School Students. *J. Chem. Educ*. **2017**, *94*, 1629-1638.
4. Erdal, N. B.; Hakkarainen, M.; and Blomqvist, A. G. Polymers, Giant Molecules with Properties: An Entertaining Activity Introducing Polymers to Young Students. *J. Chem. Educ*. **2019**, *96*, 1691-1695.
5. Fagnani, D. E.; Hall, A. O.; Zurcher, D. M.; Sekoni, K. N.; Barbu, B. N.; and McNeil, A. J. Short Course on Sustainable Polymers for High School Students. *J. Chem. Educ*. **2020**, *97*, 2160-2168.
6. Schiffer, J. M.; Lyman, J.; Byrd, D.; Silverstein, H.; and Halls, M. D. Microplastics Outreach Program: A Systems-Thinking Approach to Teach High School Students about the Chemistry and Impacts of Plastics. *J. Chem. Educ*. **2020**, *97*, 137-142.
7. *Polymer Chemistry,* by Sebastian Koltzenburg, Michael Maskos, and Oskar Nuyken, Springer, 2017.
8. *Organic Chemistry Principles and Industrial Practice*, by Mark M. Green and Harold A. Wittcoff, Wiley-VCH, 2003.

化學科知識增益專業培訓課程

主題：　塑膠的未來

講者：　香港中文大學　化學系

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目標：

1. 介紹塑膠材料的重要性；
2. 加強教師了解製備某些重要聚合物時的聚合過程和機理；
3. 講解常見塑膠的化學結構差異，並了解這種差異是如何導致某些塑膠在海洋中變得易於分解，形成微塑膠；
4. 討論目前塑料的回收、發展情況，以及生物基/可降解聚合物的使用狀況。

摘要：塑膠的主要組成成分是聚合物，同時會加入各種各樣的添加劑（如阻燃劑，塑化劑等）來調控其物理性質。塑膠的主要來源是化石燃料，被應用於人類生活的各個方面，如食品包裝、電子器件，輕型電動交通工具，建築以及其他領域，為我們的生活提供了巨大的便利。儘管塑膠為人類帶來了很多益處，它們也造成了巨大的環境污染。在全球各地，每年共消耗約160億個即棄咖啡杯，每天亦丟棄約50億根塑膠飲管。由於絕大多數塑膠不可降解，目前通用的回收策略也基本上不太有效，這些即棄塑膠一般會被當作廢物直接送至堆填區或傾倒至海洋，對環境和海洋生物造成了很大危害。因此，發展環境友好及生物可降解材料來替代現有的塑膠製品逐漸成為構建可持續型未來的新需求。在本課程中，我們將討論重要聚合物的製備及其優異性能，包括鏈增長聚合、逐步聚合過程以及聚合物的化學結構對其物理性質的影響。此外，還將重點介紹目前我們使用的塑膠在回收過程中的挑戰，以及當前生物基及生物可降解聚合物的發展狀況。

推薦閱讀材料：

1. The future of plastics – C&EN – American Chemical Society (ACS), 2020. https://cen.acs.org/sections/discovery-reports/the-future-of-plastic.html
2. Science to enable sustainable plastics – The Royal Society of Chemistry (RSC), 2020 https://www.rsc.org/new-perspectives/sustainability/progressive-plastics/
3. Ting, J. M.; Ricarte, R. G.; Schneiderman, D. K.; Saba, S. A.; Jiang, Y.; Hillmyer, M. A.; Bates, F. S.; Reineke, T. M.; and Macosko, C. W. Polymer Day: Outreach Experiments for High School Students. *J. Chem. Educ*. **2017**, *94*, 1629-1638.
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