

SCIENCE OF POLYMERS : QUO VADIS ?

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Abstract

Polymer science is a relatively new sub-discipline of chemical science which came into existence just about a century ago. In 1909, Leo Baekeland (1863-1944) introduced a material derived from phenol and formaldehyde, called Bakelite as a replacement for Shellac, useful as an insulating material. However, it took another two decades before the macromolecular hypothesis of Hermann Staudinger (1881-1965) proposed in 1920 became widely accepted by the scientific community and polymers were recognized as organic molecules with covalent bonds and possessing high molecular weights. Soon several bond forming reactions that had been discovered in the first two decades of the twentieth century were applied to polymer forming reactions, leading to the synthesis of new forms of matter called poly(ester)s, poly(amide)s, poly(urethane)s, poly(vinyl chloride)s and poly(isobutylene)s, poly(butadiene)s etc.

The utilitarian aspect of synthetic polymers was quickly recognized. Large chemical corporations set up research programs to discover new polymers with useful applications. The advent of Second World War further provided impetus to polymer research, especially in academia. Synthetic rubbers, free radical chain polymerization and the science of emulsion polymerization was a product of intense war time research.

Post 1950, polymers became the key products of the burgeoning petrochemical industry, driven by the promise of inexpensive petroleum feed-stocks. Chemical building blocks such as ethylene, propylene, butadiene, benzene, toluene and styrene became available and large manufacturing capacities came up throughout the world. From mere curiosities, polymers became an indispensable part of our daily life and so ubiquitous that we no longer realize how dependent we are on polymers. Today, we consume over 250 million tons of manmade organic materials with a value of over US \$1 trillion, about a third of the value of the entire chemical industry.

The lecture will trace briefly the history of polymer science as well as the growth of the industry. The polymer industry, in about fifty years, has rapidly attained technological

maturity. The synthetic tool boxes available to chemists have also been substantially refined; so much so that today synthesizing a polymer molecule with precision, both at molecular and supra-molecular level, is no longer a challenge.

Therefore, as we conclude the first decade of the twenty first century it is pertinent to ask what is the challenge facing polymer science? How will this science address some of the most challenging problems faced by our society today? What are the technology fronts and scientific frontiers? Why is there a seemingly a lack of exciting discoveries at the current time? What are the barriers to introducing new materials in the market? Can we define some holy grails of polymer science?

The lecture will attempt to seek answers to some of these questions.