*al*. A bottom up approach to building such structures (3D printing?) promises to be of value in sensing and other fields. Superfluid helium nanodroplets provide an exotic and exciting topic for investigation and also a unique medium to study weakly bound complexes. Imaging quantum vortices in superfluid helium droplets give us detailed access to the wave function describing the quantum fluids, as shown by Gessner and Vilesov in their review of the subject.

Photochemistry of molecules like ozone and others in the earth's atmosphere is of immediate interest for our survival and that of other species on earth and above (and below too). Much of the action seems to take place at the interface between air and water and in aerosols. Zhong *et al*. provide an insight into various photochemical processes occurring at the interface. Manfredi *et al*. discuss the photochemistry of organic retinal prostheses that are of value in improving the vision of the less abled or the ones who end up with vision impairment in an accident.

Microscopes, as soon as they were invented, opened a gateway into the biological world that was not obvious to the naked eye. From static images to live cell imaging, microscopy has come a long way. Morris and Payne review the recent developments, particularly in the area of fluorescence imaging. Zhu *et al*. describe in detail the principle behind transient absorption microscopy that provides insight into carrier and exciton transport. Interferometric scattering microscopy (iSCAT) is the new tool that has begun to unravel the mysteries of biomolecular dynamics and interactions as discussed in the review by Young and Kukura.

The central dogma of molecular biology is that DNA carries information that is transferred to RNA, which in turn produces proteins. The question of the difference between DNA and proteins, when it comes to electron transfer is addressed by Beratan.

Reading all of the above exciting topics may make the reader wonder if thermodynamics and kinetics is still of any value to (physical) chemists. The answer in the affirmative is given by Bernetti *et al*. in their review of drug binding and residence time.

Overall, *ARPC* 2019 was worth a read for me (and I hope it would be for anyone interested in physical chemistry) in my endeavour to keep abreast of the recent developments in physical chemistry.

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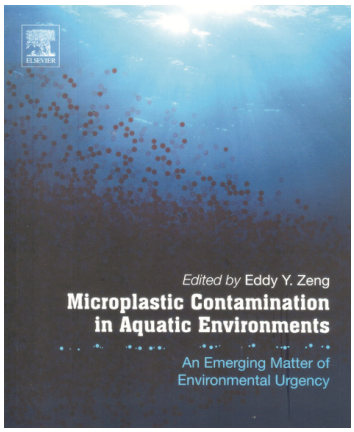


**Microplastic Contamination in Aquatic Environments: An Emerging Matter of Environmental Urgency.** Eddy Y. Zeng (eds). Elsevier 50 Hampshire Street, 5th Floor, Cambridge MA 02139, United States. 424 pages. Price: US$ 125.00.

Marine microplastic pollution has drawn global attention and the need for appropriate remedial measures is being increasingly sought. The book edited by Eddy Y. Zeng brings out several aspects of the challenges that are important in this context. The book has thirteen chapters authored by several authors.

The book begins with a review article by Woon Joon Shim *et al.* on the abundance, distribution and composition of marine microplastics. It provides an account of the distribution of microplastics in seawater, sediment and composition by size, shape and polymer type. The distribution and fate of microplastics in aquatic environment are regulated complex physical and chemical processes. This article brings out the current knowledge of the spatial and temporal distribution of microplastics, and emphasizes the importance of systematic monitoring. It emerges out that mere cataloguing of the abundance and the diversity based on physical features, though a good beginning, will have limited application or management utility. In this context, a wholistic source to sink evaluation approach will be needed. Such an integrated approach needs careful planning and trans-disciplinary execution.

Limitations of microplastic quantification in the ocean and freshwater systems are addressed by Shiye Zhao *et al*. and Rachid Dris *et al*. Their analyses provide an overview of the methodologies adopted and how they vary. Limitations of the methods adopted and their variability point towards comparison across the regions a difficult task. They also bring out that consistency of analytical techniques should be the first priority in this area of research. This facet of microplastic pollution research is critical, if one intends to build a robust and reliable database. The monitoring efforts should establish standard protocols, test their reproducibility prior to embarking on large domain observations and transboundary inferences.

Freshwater systems are a major source of plastic introduced into the environment. In spite of the proximity and observational ease, information from freshwater systems is limited when compared to marine ecosystems. Dafne Eerkes-Medrano and Richard Thompson point out through their analyses that an integrated approach which deal with methodology applied, conditions influencing the quantity of microplastics in the freshwater environment are important and need attention. Efforts related to quantification of microplastic contamination in the rivers have benefits on the understanding of their fate in estuaries, coasts and the oceans. This once again reiterates that the evaluation of the pollutant quantity, source, physical and chemical characteristics at its origin has to be integrated for an effective assessment.

Land-based sources are the major contributors of plastic debris in the marine environment (stated as 75–90%) and the remaining generated from ocean-based sources (shipping, fishing, recreation and offshore industries). Wai Chin Li dealing with the occurrence rate and effects of microplastics in the marine environment raises the importance of awareness amongst stakeholders and education of plastic waste management, especially amongst the operators of fishing vessels. Surveillance of intentional or negligent dumping of plastics in the oceans also

need attention, as the prevailing measures are inadequate.

The transport properties of the microplastics in the oceans are not well understood and advancements in this area are much needed. The physical properties of the micro-plastic particle keeps changing, thus tracking the dispersion or movement of particles is a daunting task and important from the modelling perspective. Irina Chubarenko *et al*. provide insights into the behaviour of microplastics in coastal zones and the importance of physical properties of microplastics such as density, shape and size in their distribution.

Microplastics can leach toxic chemicals (e.g. nonyl-phenol, polybrominated diphenyl esters) which are used as additives to improve the physical and chemical properties of the plastics. Microplastics also serve as substrates for sorption of harmful chemicals in the environment such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Transfer of these toxic and harmful chemicals through food chain is a serious concern for the health of ecosystems. Fen Wang *et al*. deal with sorption of toxic chemicals on microplastics and provide information of common chemicals adhering to microplastics. Sang He Hang *et al*. describe chemical categories and chemicals of concern found in microplastics and provide a basis for categorization, whether they are originating from the plastic or sorbed from the environment. There are contradictory opinions regarding the true vector of hydrophobic persistent organic pollutants in the food chain. The uncertainties arise due to the reality that the persistent organic pollutants also have a ubiquitous distribution in nature. Segregation of the source and pathways has been difficult. Michele Harmon brings out that while effects associated with persistent organic pollutants sorbed to microplastics have been hypothesized and even supported by some studies, the differences in methodologies and other questions related to environmental relevance show that there is still much work to be done.

Pollution prevention is easier, when tackled at the source of contamination. Domestic and industrial sewage are among the major source of microplastics. Microplastics also serve as habitats for specific microorganisms, and alter the composition of the receiving water body. These discharges are generally processed through wastewater-treatment plants. Huase Ou and Eddy Y. Zeng in their assessment of occurrence and rate of microplastics in wastewater-treatment plants delve upon sampling, pre-treatment and analytical methods, classification and source of microplastics and their fate, discharge of microplastics from wastewater-treatment plants. Their analyses conclude that primary and secondary treatment in wastewater-treatment plants remove most microplastics and the next step includes transportation to sewage sludge. In this context, improvements in the efficiency of treatment plants will pay rich dividends in the containment of microplastic pollution. Lei Mai *et al*. point out that the focus of microplastic pollution studies has been placed on the marine environment and efforts to evaluate the fate of microplastics in the terrestrial environment are inadequate. It emerges out that retention time of plastics in soil and the degradation rate of large plastics to microplastics, is yet another facet that needs the attention of researchers and managers.

Microplastics, due to their small size can be ingested by marine organisms. Organisms which depend on filter feeding encounter microplastics to a higher degree. The ingested microplastics can either be egested or retained by the organism. The predation of microplastic loaded prey initiates the process of trophic transfer. Microplastics in marine food webs dealt by Outi Setala *et al*. brings out the entry points, cycling through different biotic components. They conclude: 'there may therefore come a time when the exposure experiments that are carried out today and that have been criticized because of their high microplastic concentration will be considered as "historic" research with environmentally relevant concentration.'

Concern for nanoplastics (synthetic or semisynthetic organic polymers with at least one dimension between 1 and 100 nm) in the aquatic environment is also gaining momentum in the recent years. Karin Mattson *et al*. highlight the ecological effects of differently sized plastics. They point out that interaction and behaviour of nanoparticles with living organisms differ from those of larger pieces of bulk material because of their unique nanoscale properties. It is also possible that material known to be non-toxic in bulk can be toxic in nanometre scale due to its characteristic properties. Their smaller size also enables passing through biological barriers and accumulation in organs. This signifies the importance of research related to nanoplastic pollution which is at its infancy.

Articles in the book are backed by well researched references and bring out future directions for microplastic contamination research and its management. I consider this book a useful reference material for those interested in aquatic pollution.

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