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Opinion

Circular Seas - The Next Challenge for Plastics

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Opinion

The 20th century was dominated by the development of plastics. Walker has described plastics as the building blocks of the 20th century [1]. The ingenuity of polymer chemists to prepare polymers tailored for particular applications ranging from the safe transport of water and electricity, through affordable household goods and lightweight cars to medical applications, coupled with development of high through put manufacturing technologies such as film blowing, fibre spinning, and injection molding have powered these developments. In the late twentieth century, there was a growing realization of the downside of widely available durable plastic goods. There are two strands to this downside. The first is focused on the impact of the production, use and disposal of plastics on the atmosphere, in particular the contribution to Global Warming and Climate Change. It is interesting to note that Global Warming and Plastics have a rather similar timeline in terms of scientific discovery. The start of the plastics revolution is associated with the work of Baekeland in developing Bakelite [2] and not long afterwards Staudinger published his groundbreaking work on the concept of long chain polymers [3,4]. At the start of the 20th century Svante Arrhenius had highlighted in his Nobel Laureate Address that carbon dioxide may play a part in fixing the temperature of the earth [5]. In 1938 Guy Callendar published a paper "The artificial production of carbon dioxide and its influence on temperature", he also attempted to attribute the rise in global temperatures in the first part of the century to increase levels of carbon dioxide [6]. In the 1950s there were great strides in Global models of the atmosphere and by 1975 Wallace Broecker published a scientific paper titled "Are We on the Brink of a Pronounced Global Warming?" [7]. This introduced the phrase "Global Warming" for the first time which led to an acceleration in the focus on climate change. In 1988 the Intergovernmental Panel on Climate Change was launched at the United Nations, and it has been publishing reports ever since then and it is now its sixth assessment exercise to inform the 2023 Global Stock take by the UN on progress towards the Paris Accord to limit Global Warming to 2.0 °C [8]. A recent publication by Cabernard et al. [9] shows that carbon dioxide equivalent emissions from plastic production and use continue to grow and in 1995 they contributed 4.5% of all emissions. There is much public call for the reduction in the use of plastics, but in part the reduction in carbon dioxide equivalent emissions can be reduced by reversing the shift to coal-based power and move towards the use of clean energy such as direct solar power. Although much attention has been directed at reducing the carbon footprint, the last third of the 20th Century saw the revelation of a major catastrophe for the oceans. In the late 1960s the first evidence for marine pollution by plastics was reported in the scientific literature [10], in the form of plastic parts recovered from the stomach of an albatross. This was followed by much anecdotal evidence but Thompson et al. [11] revealed the extent of plastic pollution of the world's oceans. We now know that this is not just restricted to the plastics island in the Pacific Ocean, but the micro-remnants of plastic degradation are everywhere and form part of the food chain of the oceans and therefore of humans. It is claimed that "Without significant action, there may be more plastic than fish in the ocean, by weight, by 2050" [12]. Whereas the challenge of the emissions from the production and use of plastics has a variety of solutions, the plastic waste in the oceans seems an insurmountable challenge. We estimate the volume of the oceans as 1.3×10^{21} litres [13]. The most powerful of filtration systems can process 57×10^{6}

litres/day meaning a filtration time of 6×10^{11} years. To reduce this to a single person's lifetime means 8×10^{9} filtration systems! This gives rise to huge material and power requirements.

Plastics are not the direct cause of this pollution, human beings are. We assert that the route to begin reducing pollution is to increase the value of recycled plastics so as to make such materials highly valued items. The recycling industry has developed along rather limited lines. It seeks to sort waste into material types and thereby recreate plastic based materials which can substitute for the virgin plastics used to create the product. The current practices lead to a substantial volume of plastics not being recycled and those which have reduced properties. As a consequence, it may be cheaper and more expeditious to dispose of the plastic waste through energy recover incineration or dumping in the sea. It provides little incentive to collect plastic waste for recycling and in doing so reduce the carbon footprint. The Circular Seas project [14] is a European Consortium of 8 partners located on the Atlantic shoreline and is focused on promoting the Green Economy by encouraging the development of eco-innovative or green products, parts and components for the Maritime Industries. The strategy is a combination of the Circular Economy Principles, with the use of Ocean Plastic Waste as a means to develop new green materials and the introduction of new greener materials, and the uptake of an advanced manufacturing technology, 3D printing, which is flexible enough to adapt to the manufacturing conditions required for new eco-innovative small and medium parts and components. To add value to recycled waste requires the use of innovative product design and material processing technology. 3d printing has the ability to meet such demands [15]. Figure 1 shows some of the steps in the transformation of marine waste to marine products by 3d printing. The catamaran (0.5m length) shown here is a prototype prepared using 3d printing technology, the final product will be produced from recycled marine waste and will be 3m in length. The large size of the product underlines the volume of recycled material required. In summary, to limit the continued pollution of the oceans, we need to greatly increase the value of recycled plastics and developing manufacturing streams which involve significant volumes of recycled plastics. 3d printing can deliver the innovations required in design and fabrication to produce added value products.

Figure 1: A graphical representation of the steps in transforming marine plastic waste into high value products. Left: Marine industry waste centre granulated waste. Right: A prototype catamaran 0.5m in length.

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References

1. Walker A (1994) Plastics: The building blocks of the twentieth century. The Construction History Society 10: 67-88.
2. Baekeland LH (1909) Method of making insoluble products of phenol and formaldehyde. US Patent 942.
3. Staudinger H (1920) Uber Polymerization. Chem Ber 531(6): 1073-1085.
4. Frey H, Johann T (2020) Celebrating 100 years of polymer science: Hermann Staudinger's 1920 manifesto. Polym Chem 11: 8-14.
5. Nobel Lectures (1966) Chemistry 1901-1921, Elsevier Publishing Company, Amsterdam, Netherlands.
6. Callendar GS (1938) The artificial production of carbon dioxide and its influence on temperature. The Quarterly Journal of the Royal Meteorological Society 64(275): 223-240.
7. Broecker WS (1975) Are we on the brink of a pronounced global warming? Science 189: 460-463.
8. IPCC The Intergovernmental Panel on Climate Change.

9. Cabernard L, Pfister S, Oberschelp C, Hellweg S (2021) Growing environmental footprint of plastics driven by coal combustion. Nat Sustain.
10. Kenyon KW, Kridler E (1969) Laysan Albatross swallow indigestible matter. Auk 86: 339-343.
11. Thompson RC, Moore CJ, vom Saal FS, Swan SH (2009) Plastics, the environment and human health: current consensus and future trends. Phil Trans R Soc 364(1526): 2153-2166.
12. Ellen MacArthur Foundation (2016) The New Plastics Economy Rethinking the future of plastics. World Economic Forum.
13. Volumes of Oceans.
14. CircularSeas.
15. da Silva DP, Pinheiro J, Abdulghani S, Kamma Lorger C, Martinez JC, et al. Changing the Paradigm – 3d printing is more than form.