

Homework 11 Plastics in a Circular Economy

This week we covered biopolymers and additives in the circular economy.

- a) In the notes the following list was given for the ideal biopolymer:
- 100% properties until planned degradation lifetime when it totally degrades
 - Degradation products are non-toxic and non-eutrophic
 - (Degrades into O₂ and N₂ for instance)
 - Costs less than petrochemical plastics
 - Manufactured from a renewable resource (sunlight or seaweed)
 - Doesn't compete with food production
 - Tunable properties such as barrier for films, modulus for injection molding
 - Totally interchangeable with existing plastics processing with no
 - adjustment of processing equipment (plug and play)
 - Doesn't require additives or non-toxic, biodegradable additives exist

Give an example of one or more bioplastics that meet each of these conditions independently.

- b) Argue and give examples of biological tissue such as skin, bone, or mucus that can meet all the conditions or part "a" and more. For instance, does skin color (a pigment additive) biodegrade non-toxically? Is an orange or banana peel the perfect flexible packaging? You can probably come up with some examples.
- c) Compare PLA and PHB (or PHAs) by sketching out their cradle-to-cradle life cycle. How these two semi-crystalline polymers synthesized? Are these polymers biodegradable (find some differing opinions)? How do the mechanical properties of these two differ from polyethylene or i-polypropylene?
- d) Amit Kulkarni from Avient had a discussion with the class on Thursday. In 2000 Geon (polymer processing and compounding specializing in PVC a former division of B. F. Goodrich) merged with M. A. Hanna (rubber and other polymer processing) to form Polyone worth \$3.5B. In 2020 Polyone purchased Clariant (Swiss plastics pigments) and renamed to Avient. In 2021 Avient purchased MagnaColours (UK screen printing ink company). In 2022 Avient purchased a \$1.5B additive part of DSM. Avient currently has annual revenues of \$3.5B. Kelly Williams of EarthFirst mentioned that consolidation in the plastics industry has had an impact on the ability of small companies to introduce bioplastics. Is Avient an example of this consolidation? From the discussion with Amit what is your assessment of the progress that the plastics additives industry has made towards a circular economy. Is consolidation good or bad for progress in this direction?
- e) Avient is a founding member of the Alliance to End Plastics Waste. What is the intent of this organization. Is this an effective way towards a circular economy in plastics. How are this organization and Avient addressing the issue of additives in plastics preventing circularity in plastics?