

MSE 214 (Polymers)
Exercise 6 – Processing and Sustainability
12th Nov 2025

Question 1.

a) A company is considering switching from conventional polymer to a biodegradable polymer for its packaging. The conventional polymer has a carbon footprint of 5 kg CO₂ per unit, while the biodegradable polymer has 3 kg CO₂ per unit. If the company produces 500'000 of these units annually, how much carbon dioxide can be saved each year by switching to the biodegradable polymers?

b) However, the biodegradable polymer degrades faster, requiring replacement every 3 years, while the conventional polymer lasts for 10 years. The company needs 500'000 of these units in operation. Over a 15-year period, considering the replacement cycles, how much total CO₂ emissions would each option produce, and what is the net CO₂ savings (or loss) if the company switches to the biodegradable option?

Question 2.

Recycled polymers often have poor mechanical properties when different types of plastics are not properly separated during the recycling process. Give two reasons why this happens.

Question 3.

Biodegradable polymers are considered to be eco-friendly because they can decompose in the environment. State 2 possible unintended consequences of having these biodegradable polymers decompose in the environment.

Question 4.

In class, we discussed the working principles of vat photopolymerization and how it can be used to 3D print polymeric structures. Vat photopolymerization can also be used to make composite structures (polymers + ceramic/metal particles). To do so, a slurry is first prepared by mixing the photoresin with ceramic/metal particles. This slurry is then used with a vat photopolymerization process to make the composite structure.

Unfortunately, this process is very challenging and often results in inaccurate and/or inhomogeneous parts. Give 2 reasons why you think this is the case.

Hint1: What happens when you mix sand and water together? How does the consistency change? What happens over time?

Hint 2: What do you think happens to the transparency of the resin?

Question 5.

a) What is the difference between a negative and positive photoresist? How does the type of photoresist change the pattern that you expose onto it for patterning?

b) You need to pattern some copper traces onto a PCB. Starting with just the PCB, and using what you've learnt about photolithography, deduce how you would do it using a positive photoresist. You have access to a copper sputterer that deposits copper evenly over the surface of your substrate. You also have access to a spin coater that can coat your substrate with the photoresist.

Question 6.

State 2 advantages and 2 disadvantages of conventional manufacturing (like injection molding) and additive manufacturing (like material extrusion).