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# Two Birds With One Stone: Recycling Carbon Dioxide to Produce Plastic

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## *Recycling Carbon Dioxide to Produce Plastic*

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Society is addicted to plastic — and demand is expected to increase rapidly — from 400 million tons in 2020 to nearly 600 million by 2050. At all stages of the plastic life cycle, carbon is emitted into the atmosphere, clogging our air with heat-capturing chemicals that accelerate climate change. In the plastic production process, fossil fuels extraction, refining, and manufacturing into plastic precursors all use energy and release loads of carbon emissions.. When plastic waste is not managed correctly and left in the environment, as it degrades, it releases these toxic chemicals back into the environment.

Immediate action is needed to lower plastic use and the resulting carbon emissions, but stopping emissions is no longer enough. With the amount of carbon dioxide in the air, the planet will continue to warm even if no more is emitted. Carbon needs to be pulled out of the atmosphere to cool the Earth, and not just stored, but used productively. Recycling carbon would effectively close the loop, so it does not get released into our atmosphere and congest our planet.

Since the 1970s, scientists have been using Carbon Capture and Storage (CCS) to mitigate the amount of carbon dioxide released into the atmosphere. In CCS technology, carbon dioxide is captured near places of emission (like smokestacks or coal-fired power plants) and pumped underground. Permanently trapped in coal seams and deep saline reservoirs, the carbon dioxide cannot pollute the atmosphere. Currently, there are 27 facilities around the world that practice CCS, 12 of which are based in the United States.

But what if plastic could not only be captured and hidden forever, but used in a practical and beneficial way? Carbon Capture and Utilization (CCU) technology aims to pull carbon dioxide out of the atmosphere and recycle it to be used in everyday products that otherwise rely on freshly dug, fossil-fuel-based carbon. CO2 is already used in products like soda to make it fizzy. With CCU technology, the carbon in these products would be taken from the atmosphere and given a second life – recycling the carbon in a helpful way rather than letting it waste away. The key is to use fossil fuels already above ground and in our system rather than digging for new fossil fuels deep in the Earth.

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CCU is similar to CCS, first capturing carbon dioxide using infrastructure such as industrial factory chimneys. Next, electrolysis is used to split water into hydrogen and oxygen with electricity. The hydrogen from electrolysis is combined with recycled carbon, and the molecules reassemble, producing hydrocarbon compounds, which can be processed into plastic precursors, like ethylene and propylene. Precursors are bound together to produce plastic for solar panels, smartphones, mattresses, jet fuel, cement, plastic cups, or even clothes.

One concern is how much energy – and what kind – is being used for this process. Using more dirty, fossil-fuel-based energy to recycle carbon is not necessarily better than just letting the carbon go into the atmosphere. Ideally, the hydrogen used in CCU would come from clean energy sources, like wind or solar power. Another difficulty is the specific equipment needed for CCU, which is expensive and not subsidized by the US government.

Despite these challenges, research facilities are working hard to find feasible ways to recycle carbon into everyday products, cleaning the atmosphere. For example, LanzaTech, a company based in Illinois, has recently tackled the problem of plastics in the fashion industry. Polyester fabric is made from melting plastics and spinning and stretching them into fibers, which are then used in clothing. Every time we wash our clothes, tiny pieces of polyester go into the ocean and atmosphere, making even our clothes a danger to our planet.

As a CCU solution, LanzaTech uses living microbes to turn carbon dioxide into plastic material that manufacturers can incorporate into polyester clothing fabric. LanzaTech has two facilities in China that use acetone and methanogens, two kinds of microbes, to convert CO2 into industrial chemicals, like ethanol and then polyester, through simple metabolic pathways. Clothing is made from this carbon-recycled polyester. In 2021, ZARA, a Spanish multinational retail clothing chain, used LanzaTech's polyester fabric in a line of their dresses, producing dresses from recycled fabric.

The ethanol produced by LanzaTech is much cleaner than ethanol from fossil fuels. A life cycle assessment study found that the LanzaTech ethanol production process had 80 percent lower greenhouse gas emissions than traditional fossil-fuel-based ethanol productions. Further, the only waste product from this process is dead bacteria, which can be used as compost or animal feed and put back into the environment in a useful way – making this a truly green, closed-loop style of producing plastic.

Currently, carbon and plastic lead to toxic lifestyles that fuel each other. Carbon is key in making plastic, and plastic inevitably releases copious amounts of carbon into the atmosphere. Up-and-coming CCU technology, however, creates a cohesive and productive network between the plastic and carbon life cycles. Recycling carbon to produce plastic provides a viable pathway to utilize pollutants in our atmosphere and close two harmful loops. New advancements like these are killing two birds with one stone to create a sustainable future. • • •