About reducing the fossil fuel addiction via compostables

From a historical perspective, it is quite remarkable to see how geopolitical events can have an unexpected influence on the way we deal with our materials. During the American civil war, around the 1860s, a company in billiard supplies, called Phelan and Collender, faced a serious shortage in their supply of ivory as a direct result of the war. The company offered a USD 10,000 award for anyone who could offer an alternative material for making billiard balls. It led to the development of a cellulose-based material called Parkesine, which is often seen as the world's first (semi)synthetic material that was ever made.

Wallace Carothers – a Harvard professor in organic chemistry – only joined Dupont after significant pressure, to then further investigate the concept of macromolecules in 1928, which was formulated by Staudinger in 1920. Carothers patented numerous materials like Nylon (polyamide), various polyesters (incl. PLA), and Neoprene (synthetic rubber). When the United States got involved in WW2 in 1941 there was an urgent demand for lightweight materials in planes. As Japan had occupied the countries holding natural rubber plantations, it was good to have synthetic alternatives available. Nylon – promoted originally as artificial silk for lady's stockings – came in handy as an alternative for regular silk for parachutes, as Japan was also in control of the global silk market.

In 1973 the Yom Kippur war led to an oil and energy crisis in various western countries, when Arab countries decided to cut supplies to countries, who had chosen to side with Israel in this conflict. It is unlikely to be a coincidence that the first materials where starch was combined with synthetic polymers appeared in the market in the mid 1970s. Initially, it was only a cheap filler to reduce crude oil dependency, but was soon linked to biodegradable materials, e.g. in mulch film applications.

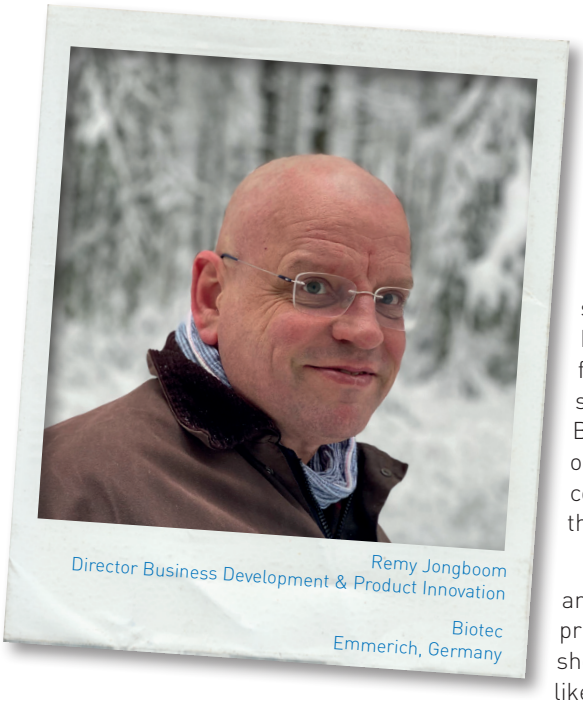
Even at the grand opening of NatureWorks' PLA facility in Blair (USA) in 2002, one of the key-note speakers asked the audience if they "want their raw materials to come from the Midwest or the Middle East", referring to the attacks of 11th September 2001.

The recent geopolitical developments have been putting pressure on the situation related to energy supply. If we want to have a situation in Western Europe where the gas supply is re-evaluated, the short-term solution will be in shifting energy sources, away from natural gas towards oil, coal, lignite, and even nuclear energy. The side effects that are likely to occur in such situations are often ignored. Uncertainties for the future may influence the stock market, inflation might rise (significantly), and interest rates are likely to go through the roof in the upcoming months as well – even if a peaceful settlement can be reached soon.

Have we learnt nothing from the oil and energy crisis of 1973? Unpredicted changes in the price and availability of crude oil and raw materials (like plastics) have been the start of a strong recession that lasted for almost a decade. Which in turn lead to high unemployment rates and strong increases in prices. Yet the consumption of energy and plastics did not change. There seems therefore to be a direct connection between economic growth (GDP) and the consumption of plastics. Before 1973 there was a direct correlation between energy use and the development of the GDP in Europe. After 1973 there was a clear separation visible, with a growth of the GDP and a diversification in energy supply.

For around 30 years the bioplastic industry has been developing new materials and processes, especially in the area of compostable materials. Initially, the driving force (in the early 90s of the previous century) was linked to agriculture. Creating added value for farmers was the focus of almost all starch producing companies – only a few companies from that pioneering phase managed to make the translation from starch to the world of plastics and packaging. Since these days, the bioplastic industry has been sending out different signals to the industry. Environmental benefits had to be clarified, separate waste separation was promoted as an approach to reduce landfills, climate change was addressed, and being biobased received attention. We have seen various *hypes* like agrification, the cradle-to-cradle approach, and currently, we are in the middle of the circular economy mantra.

The plastic industry has kept on growing, and as environmental impacts become more and more visible to the general public (like the Plastic Soup), the communication on plastic recycling has been intensified. Unfortunately, it becomes increasingly eminent that mechanical recycling is simply not the holy grail that the plastic industry and big brand owners are trying to make it out to be. The European Plastics Pact had the ambition that the industry would reduce the consumption of plastics and increase recycling. Ambitious targets and voluntary agreements have been presented to the general public. How close to achieving these targets are we, and is it even realistic that we will reach them at all? Consumption of plastic has increased instead of decreasing, and the use of recycled plastics in packaging is still at embarrassingly low levels compared to glass, metal, and paper. The industry is kicking the can down the road with a new *magical solution* called chemical recycling. The processes that are being investigated are



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(with the exception of chemical recycling of PLA) far more expensive than using virgin materials like PE or PP, can be quite energy-intensive, and are overall rather controversial.

What is missing to reach the necessary transition is a proper driving force. For companies that are using regular plastics, making a shift is expensive and risky. And as long as consumers believe that there are realistic environmental solutions in place - which help to reduce their guilty conscience – it will be difficult to achieve breakthrough changes. Yes, some brands and retailers have made enormous propaganda for their *green solutions*, but if you look at the relative numbers they were rather homeopathic in nature. And many positive initiatives have been stopped as soon as the actual target, creating brand value and a positive image, was achieved. Multi-billion companies have marketing departments that can easily spend large amounts of money on communication to influence public opinion. That is their job. But as soon as the shareholder value comes under pressure and the competition is not following, environmental aspirations are thrown out the window again – quietly.

In this context, it is also interesting to analyse the waste processing companies. There is an overcapacity of waste incineration plants in various regions in Western Europe. Coincidence or not: these are also the regions with the highest resistance against the use of compostable materials. Waste incineration plants earn more money if they run at full capacity. Considering that a waste incineration plant costs around EUR 1 billion to build, with a technical life expectancy of at least 30 years, it is not surprising that such companies try to protect their shareholders' value. Municipalities that have difficulties dealing with low budgets easily fall into the hands of a company with overcapacity in incineration. There is no proper environmental driving force to change the status quo that can compete with this strong financial motivation to make ends meet.

What do the considerations as described above mean for the bioplastic industry? The recent geopolitical developments might be a breaking point. We cannot take cheap energy and oil supply for granted anymore and we might be forced to reconsider how we deal with our resources and waste. Most compostable plastics are (partially) biobased. Examples like PLA and PHA are 100 % biobased, and starch blends have increased their biobased share over the last 5 years from 25 % up to more than 60 %. A silent revolution or a rapid evolution? Biobased monomers like butanediol or succinic acid can be produced at competitive prices compared with their fossil-based alternatives.

So far, mainly feedstocks like starch and sugar have been considered as primary sources. However, we could, or should, also consider other feedstock like side streams of the food processing industry. Even wastewater plants can be used to produce new raw materials like PHA. While technically possible, they were often too expensive in the reality of yesterday. Mainly due to the relatively low costs of fossil energy and its abundant supply. This has recently changed, and it is not clear yet if these days will ever come back again, for better or worse. Compost can help to improve the structure of the soil and contains a certain amount of nutrients. Using more compost not only has a climate-friendly carbon binding potential but also reduces the need for energy-intensive mineral fertilizers. And if renewable energy sources like solar and wind energy keep on increasing in importance, then the conversion of organic waste, including compostable plastics, towards biogas may help to secure our energy supply when the sun is not shining and the winds are not blowing.

Hopefully, the acts of war in Ukraine will soon come to an end. And maybe in 5 or 10, years we will look back at the current events as the big catalyst that led to major changes in the Western World on how we will look at and deal with our resources and waste streams. The cleaner technologies are available and getting cheaper – lucrative opportunities that bring change are there, with environmental benefits as positive side effects. The driving force for change is a new and unpredictable one. Only the future will tell us if we will manage to maintain and improve our current standards of living and freedom even further, by kicking our fossil resources addiction.

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