Renewable Polymers from Biomass, CO_2 and Recycling – Status and Outlook

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The impact of fossil carbon embedded in chemicals and polymers is today still mostly neglected. Nevertheless, the only way for chemicals and polymers to become sustainable and part of the circular economy is the complete substitution of fossil carbon with renewable carbon from alternative sources: biomass, CO_2 and recycling.

The presentation will focus on developments in renewable polymers made from biomass, CO_2 and recycling: 2024 was a respectable year for bio-based polymers, with an overall expected CAGR of 13 % to 2029. Overall, bio-based biodegradable polymers have large installed capacities with an expected CAGR of 17 % to 2029, but the current average capacity utilisation is moderate at 65 %. In contrast, bio-based non-biodegradable polymers have a much higher utilisation rate of 90 %, but will only grow by 10 % to 2029. The use of CO_2 as a chemical feedstock for the production of building blocks and polymers has diversified in recent years. Several technologies have already been successfully implemented at the commercial level, with many more currently under development at laboratory and pilot scales. CO_2 has long been used in the synthesis of polycarbonates and polyols and is now finding broader application in other polymer sectors as well. Among the various conversion pathways, the biotechnological transformation of syngas into ethanol has reached commercial scale and stands as a key success story. Interest is also growing in CO_2-based methanol and hydrocarbons, which offer promising applications in fuels, chemicals, and polymers. In particular, methanol-to-olefin (MTO) processes based on CO_2-derived methanol are gaining notable momentum. As of 2024, the total global production capacity of CO_2-based products is estimated at approximately 2 million tonnes per year (Mt/a). This capacity is projected to grow by 2030, reflecting the rising demand and technological progress in carbon capture and utilisation (CCU). Advanced recycling technologies are developing at a fast pace, with new players constantly appearing on the market, from start-ups to chemistry giants and everything in between. New plants are being built, new capacities are being achieved, and new partnerships are established. Worldwide more than 340 planned, installed and operating chemical recycling plants are known, providing a total input capacity of 1,477 kt per annum. In Europe, there is already a considerable potential of know-
how and providers for chemical and physical recycling technologies which is reflected in the comparison with the globally installed plants and capacities.
Globally, the production capacity of advanced recycling is 1,082 kt per annum with products ranging from polymers, monomers, naphtha, Secondary Valuable Chemicals (SVC), and fuels & energy.