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PrimeView
Biocarbon materials

Biocarbon can be produced from renewable and sustainable feedstocks through thermo-chemical processes. The formation of biocarbon materials is influenced by the type of feedstocks, precursors, thermo-chemical conversion processes and the application of pre- and post-modification treatments.

Experimentation

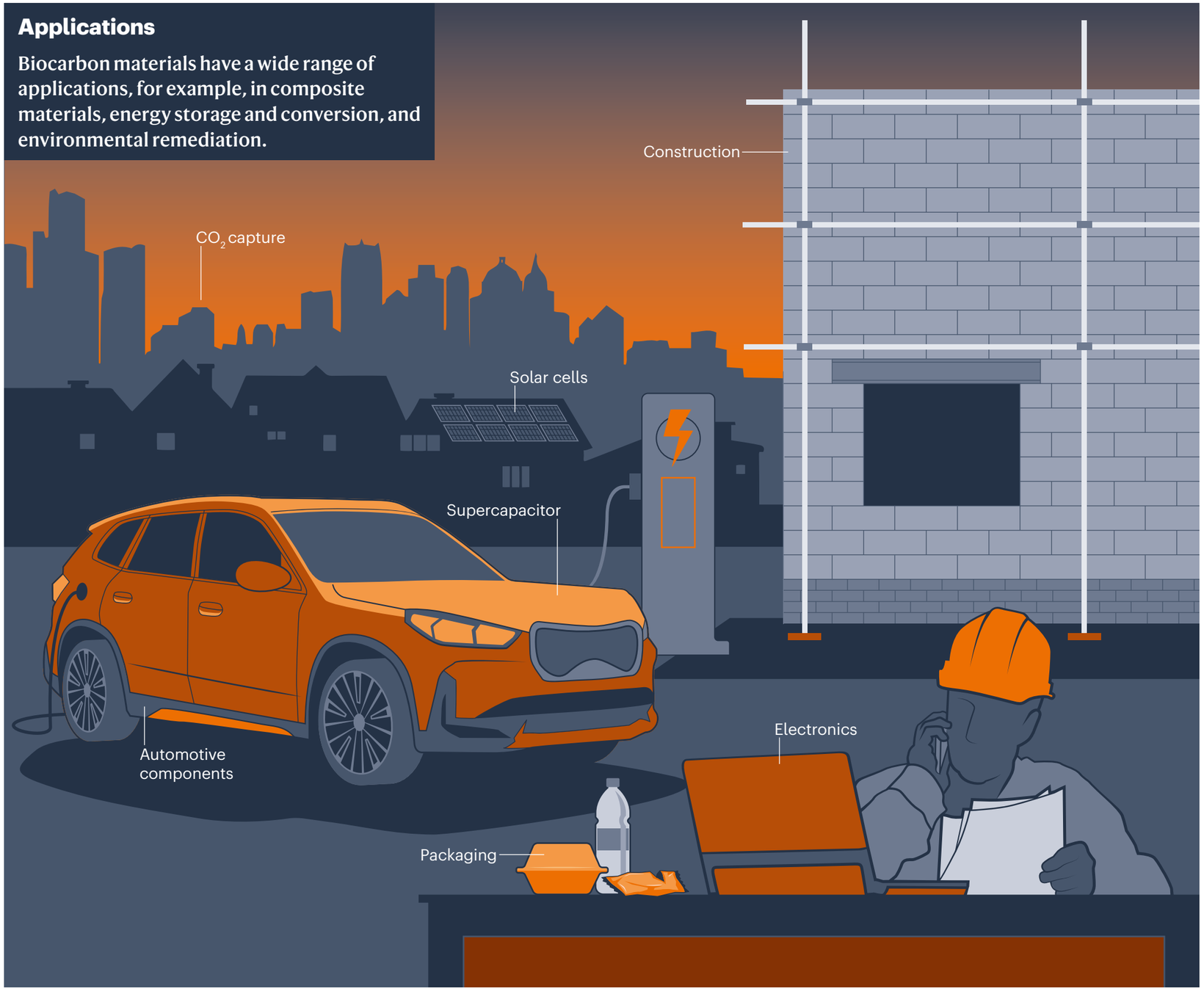
Biocarbon is produced by thermo-chemical processing (pyrolysis or carbonization) of biomass-based feedstocks whereby the feedstock is heated to temperatures greater than 350 °C in the absence of oxygen (or in limited oxygen). Thermo-chemical conversion lowers the oxygen and hydrogen content of biomass, thereby increasing its elemental carbon, energy density and porosity. The composition of biocarbon is determined by the choice of feedstock and processing techniques; for example, carbon content in biocarbon can range from 44% to 95%, while oxygen content can range from 0% to 45% and hydrogen content from 1% to 9%. Processing conditions can influence the chemical structures, fixed carbon, volatile matter and ash content. In general, longer residence times and higher temperatures increase carbon and ash content, owing to the removal of oxygen and hydrogen. These conditions also increase the fixed carbon while decreasing volatile matter.

Results

Biocarbon should be carefully characterized, owing to variations of feedstock and pyrolysis techniques. The elemental composition of biocarbon can be determined by an elemental analyser, while the volatile matter, mineral ash and moisture content can be determined using thermogravimetry. The standardized methods used for determining biocarbon's moisture and mineral ash content are ASTM D (4442-92) and ASTM D (1755-95), respectively. Techno-economic assessment evaluates costs, risks and uncertainties throughout the production process, considering parameters such as feedstock production, transportation costs, facility expenses and project revenue across the production chain. Life-cycle assessment, to determine environmental impacts of biocarbon, is influenced by production conditions and feedstock supply.

Applications

Biocarbon materials have a wide range of applications, for example, in composite materials, energy storage and conversion, and environmental remediation.



Reproducibility and data deposition

The physicochemical properties of biocarbon depend on the selected feedstocks and precursors, pre-treatments, production methods and process parameters. Furthermore, growing and harvesting conditions may influence the composition of raw feedstocks and precursors. Creating extensive databases to correlate biocarbon properties and production methods from different sources is crucial to address reproducibility challenges and establish production protocols and standards. Both the raw feedstock composition and biocarbon production process details are necessary to determine correlations with the resulting biocarbon properties.

Limitations and optimizations

There are challenges in ensuring consistent availability of feedstock with uniform properties. Country-specific biomass can mitigate availability issues, for example, Germany and France have the potential to produce biomass from agricultural residues whereas Sweden and Finland are rich in forestry-waste biomass. Biocarbon can be integrated with polymeric products; however, the heterogeneity of biocarbon may lead to product inconsistencies. Collaboration is crucial to develop a global biocarbon-based circular economy.

Outlook

Biocarbon holds potential for applications in materials, environment and energy. Sustainability and commercial viability of biocarbon technology depend on cost-effective production, application diversity and end-user adaptation. Key approaches, such as life-cycle analysis, socio-economic impact studies and techno-economic analysis, are vital for biocarbon-based technologies.

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