

## **Green Chemistry and Green Materials evolve in a changing world.**

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The COVID-19 pandemic has had a huge impact on the bioplastics industry. Indeed, during this pandemic, there has been a surge in demand for single-use plastics to make face shields or personal protective equipment and food delivery packaging. For example, Japan needed more than 600 million facemasks in the month of April 2020. In addition, virgin plastic has become cheaper than biodegradable plastics due to lower oil prices in 2020, which has had a negative impact on the demand for bioplastics. However, COVID-19 has had a favorable impact on Green industries. Hence, the demand and use of Green chemicals has increased in industries such as home care products, food, feed, and pharmaceuticals due to increased awareness of healthy living. The impact on certain household cleaning products, such as surface disinfectants and laundry care products, nutraceuticals and dietary supplements, and certain pharmaceuticals, was particularly high in 2020 and 2021. The sale of these products increased up to 96%.

Green chemical market will continue to increase. Hence, Green chemicals are produced from plant or animal waste and could minimize the hazards of chemical raw materials. The growth of the Green chemicals market is driven by the anticipated scarcity of non-renewable resources, the rising environmental concerns and the growing awareness of sustainable and less harmful products, the increase in government initiatives to promote more sustainable industry and the fluctuations in crude oil prices. Hence, in this context, the Green chemicals market is expected to increase in the next coming years. Fluctuations in crude oil prices and shifting consumer preference towards Green and sustainable products are among the main factors expected to boost growth of the global Green chemicals market. Owing to Vantage Market Research, the global post COVID-19 market size of the Green Chemicals Market is expected to grow from USD 9,893.70 Million in 2021 to USD 16684.27 Million by 2028 at a CAGR of 9.10% during the forecast period.

Additionally, regulations and legislation supporting the use of bioplastics and restrictions regarding the use of certain chemicals will provide significant opportunities for the growth of this market. Indeed, the European Commission recently announced a commitment to use existing laws to ban all flame retardants, all bisphenols, widely used in plastics, all forms of PVC, and limit all PFAS, as well as approximately 2,000 harmful chemicals found in baby diapers, pacifiers and baby products. If implemented, this restriction roadmap will be the largest ever regulatory removal of authorized chemicals. Some chemicals on the roadmap list were already subject to EU restrictions, but most of them are new. The process of banning all chemicals on the list will begin within two years. The EU has banned around 2,000 harmful chemicals in the past 13 years, more than any other region in the world. The European Environmental Bureau estimates that this new roadmap will lead to the banning of around 5,000 to 7,000 chemicals by 2030.

With these aspects in mind, this issue of *Green Materials* focuses on both the use of renewable resources and substitution of harmful chemicals.

The first paper focuses on the use of castor oil as lubricant and proposed solutions to extend utilization conditions, even at high temperature, which could also have interesting and promising application in various industrial sectors, in substitution of harmful chemicals.

In a similar substitution approach, the second contribution proposed phosphorus biobased flame-retardants for epoxy resins that allowed demonstrating high flame retardancy. Such flame-retardants could also be promising alternatives to halogen-based ones.

The third paper, focuses on hybrid joining behavior of green composites (bamboo/poly(lactic acid) (PLA)) under tensile and compressive loadings. Such hybrid joining (bonded/bolted) techniques are emerging, and could interestingly prevent premature failure of adhesive bonding, allowing enhancing lifetime of composites and thus reduce their environmental impacts.

In the fourth paper, an interesting and novel approach for the synthesis of partially biobased thermoplastic elastomers is reported. Hence, copolymers of methyl methacrylate and butyl acrylate are grafted from an ethyl cellulose backbone, leading to interesting elastomeric properties and thermal stability.

Finally, the final paper studies the influence of various additives, including nanocellulose, on the properties of urea-formaldehyde resin. This study particularly demonstrates the promising advantage of using nanocellulose on reduction of formaldehyde emissions.

Taken together, the articles in this issue reveal not only the growing attention paid to the use of renewable resources and the substitution of harmful substances, following the trends in society, but also all the interest and promises of this chemistry for the improvement of current materials and the design of new green materials.