COMPOSITE FILLERS AND CYCLIC PROCESSING OF POLYMERIC MATERIALS

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Throughout the past century, human activities have profoundly impacted the environment. Numerous scientists assert that climate change is linked to fluctuations in natural processes triggered by human industrial and agricultural activities. The rapid increase in population and waste volume only worsens the situation [1]. The adverse effects of these activities include the loss of biodiversity, which can lead to the breakdown of ecological communities and significant alterations in ecosystems.

Plastic forms a substantial portion of solid waste and is prevalent in modern life. Between 2016 and 2020, the annual production of polymer materials exceeded 330 million metric tons. It is anticipated that by 2050, global plastic production will reach approximately 1.1 billion tons. Despite this, only 9 % of plastic waste is recycled annually, 19% is incinerated, and the remainder is either sent to landfills or left unproces sed [2]. This results in water pollution since plastic waste is highly energy-efficient but costly to dispose of. Effective plastic waste management is crucial to addressing environmental pollution and achieving sustainable development. Consequently, shifting from the traditional "take-make-consume-dispose" model to a regenerative and restorative waste management model is essential.

The predominant methods for disposing of polymer waste remain landfilling and incineration. While these methods are more cost-effective, they pose significant environmental pollution risks. So, the most effective method of solving the problem of polymer pollution is the cyclic recycling of polymer waste.

Cyclic processing refers to the repeated application of processes like heating and cooling, size reduction, or exposure to environmental conditions. This can be used for various purposes, like thermal, mechanical, and environmental cycling.

However, recycled polymers usually have significantly worse physical and mechanical properties than virgin plastics. To improve their properties, composite fillers can be added during recycling.

Composite fillers enhance the properties of polymers by acting as reinforcements within the polymer matrix. The interaction between the filler and the matrix determines the overall performance of the composite material.

The main advantage of filler incorporation in polymeric materials is direct reduction of synthetic polymer content and polymer aging degree reduction during cyclic processing.

There are different types of fillers. The most common are particulate fillers, like silica or calcium carbonate, fibrous fillers, like glass, carbon, or aramid fibers, and nanofillers, like graphene, carbon nanotubes, or nanosized clays.

Combining advanced composite fillers with optimized cyclic processing techniques allows for the development of polymeric materials with exceptional properties tailored to specific applications. This synergy leads to materials that can withstand demanding conditions, offering improved performance, reliability, and longevity across a wide range of industries.

References

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