

Sustainable graphene manufacturing from wastes and its lightweight thermoplastic composites

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Plastic waste is a growing environmental and climate concern that threatens the ecosystem and leads to soil and water contamination. Although plastic recycling provides several benefits, the recycled plastics do not have the same performance as virgin plastic composites. Instead of traditional recycling processes, it is possible to produce high value-added carbon nanomaterials by using a rich hydrocarbon source in plastics and rubbery materials which are also primary source for graphene. At this point, upcycling is a significant concept to bring an end to the life cycle of materials and open various new application routes for nanomaterial production. The present work provides an insight into the importance of green synthesis methods in graphene nanomaterials synthesis by combining recycling and upcycling technologies. It is observed that different plastic wastes based on their aromaticity and alifaticity can lead to the formation of different dimensional graphene structures such as 2D sheets and 3D spheres. The produced graphene materials are used for the design of lightweight composite structures for automotive and plastic industry by reducing adverse environmental impacts and adopting energy-efficient manufacturing technologies. In addition, a scalable technology is developed to produce graphene nanoplatelets (GNP) from recycled carbon black obtained from the pyrolysis of waste tire by using recycling and upcycling technology. These graphenes produced from waste sources are comparably cheaper and eco-friendly than available ones produced from graphite flakes and thus can carry significant potential to be used as co-reinforcing agent together with primary reinforcements in thermoplastic composites. With this developed technology, a pilot production line with the capacity of 1 ton/month in Nanografen Co (start-up of Sabanci University) was established to initiate the industrialization of graphene in thermoplastic market. Nanografen becomes an official supplier of Renault and they developed OEM certified masterbatch to reduce glass fiber and mineral amount in polypropylene based interior and exterior parts. Consequently, this multidisciplinary work ensures significant innovation potential of graphene in the field of thermoplastic-based composites and overcomes the needs by addressing greenhouse gas emissions with sustainable designs.