# Back to the future with nanocarbon composite polymers

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## 1. Introduction

Polymer nanocomposites are produced by using nanomaterials, mostly nanoclays, carbon nanotubes, nanofibers, nano-oxides, and polymers, mostly epoxy resin, polyamide, light polyolefin. The relevant market size was valued at around USD 8.66 billion in 2021 and will exhibit a growth rate of over 19.1% CAGR from 2022 to 2028 [1]. Main driving forces are still the packaging and automotive industrial sectors.

Inside this big market, a growing interest is addressed towards graphene as alternative to carbon nanotubes, towards biodegradable polymers, and to provide specific properties for more sophisticated application. In parallel, with respect to technological advances, the 3D printability of these composites is a major objective. The above systems are the object of the Horizon RISE project Graphene 3D [2]. Moving from the imminent conclusion of this project, we will try to bring some considerations up for discussion on the world of nanocarbon filled polymer composites.

## 2. Nanocarbon polymer composites

Even if limited to this class of composites, the academic literature is overflowing in terms of papers dealing with this subject. Really, if changing a single filler or coupling two of them, or changing the polymer matrix, or the manufacturing technique allow to write a new publication, it’s not surprising.

However, it seems to us that, despite this huge amount of papers, less attention is devoted to profit from the specificity of nanocarbon fillers, i.e. the fact that, differently from chemical substances, you can change their size and shape and look for the effect of this change on the properties of the manufactured composite. We still need systematic studies comparing, for instance, the effect of aspect ratio or purity of the nanocarbon filling the polymer. It has been demonstrated that the aspect ratio of graphene strongly affects mechanical properties [3].

Moreover, playing with carbon nanotubes you can change length, diameter, thickness to find the best geometric parameters providing the best features for each application.

## 2. Future outlook

The world of nanocarbons is really unlimited. Carbide Derived Carbon allows a hierarchial control of porosity, the preparation of tridimensional carbon aerogel is very versatile, microporous template nanocarbons [4] show extremely high surface area. On the other hand, cheaper nanocarbon (carbon black, active carbon graphite, char) could substitute expensive high aspect ratio carbon nanotubes and graphene platelets, by controlling the morphology and excluded volume of the polymer network, instead of the morphology of the filler. The potentiality of fullerene was perhaps underestimated. We should come back to reconsider these potential nanofillers.

Bio-char, a low cost carbon based material obtained by pyrolysis of different cellulosic matrices could substitute much expensive carbon nanofillers to improve mechanical and electrical properties [5], but also reducing the relevant negative waste impact. Moreover, carbon nanotubes and graphene may be integrated into natural-fibre-reinforced polymer composites and wood–plastic composites [6].

## 4. Conclusion

Examples of future challenges for nanocarbon polymer composites will be collected and discussed in the poster which this abstract is relevant to. Future challenges will be also the footprint of a Joint lab on nanocarbon filled composite materials to be established by the Consortium Graphene 3D as a fallout of the mentioned project [2].

## 5. Acknowledgement.

Narrando acknowledges the H2020-MSCA-RISE-734164-Graphene 3D project for financial support.

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