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Structure-Related Health Effects of Atmospheric Soot Particles

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Extended Abstract

Atmospheric soot particles, mainly from incomplete combustion, have been recognized to induce adverse health effects, which may exceed fine particulate matters ($PM_{2.5}$) when regarding mass-based concentration. Toxicological research about soot particles also widely found its hazardous impacts, of which oxidative stress, inflammation and DNA damage are most important toxicity mechanisms. Soot toxicity largely depends on its own physicochemical properties. Soot particles are generally shown as fractal aggregates composed of many spherical primary particles, which mainly contain carbonaceous core (CC) and outer coating. CC is recently found analogous to reduced graphene oxide (RGO) rather than chemically inert graphene or graphite, and outer coating is most well-known for organic polycyclic aromatic hydrocarbons (PAHs) and inorganic metals.

We summarized the evidences of soot toxicity and further analysed from the perspective of structure, i.e. CC and outer coating [1]. CC and outer coating are both contributors to soot toxicity and their separate toxicity can be exerted via above three common mechanisms and some unique mechanisms such as aromatic hydrocarbon receptor (AhR)-dependent pathways. Currently, most studies still consider that outer coating plays a more major role in soot toxicity. However, the remarkably reduced bioavailability of outer coating bound on CC limits its original toxicity in the form of liquid. The presence of oxygen-containing functional groups (OFGs) in CC newly discovered may also enhance the toxicity of CC. The antagonistic interaction already found by comparing the toxicity of composite particles (CC and outer coating combined) and individual component also indicates the need of more comprehensive and in-depth research on soot toxicity.

In the context of global warming, soot particles are more prevailing and thus pose more threats on human health. Our understanding of structure-related toxicity of soot particles provides a perspective to analyse soot toxicity, for example, the toxicity of soot emitted from different sources with distinct relative proportions of CC and outer coating may be dominated by different components.

References

[1] R. Tang, J. Shang, X. Qiu, J. Gong, T. Xue, T. Zhu, Origin, Structural Characteristics, and Health Effects of Atmospheric Soot Particles: A Review, Curr Pollution Rep (2024). https://doi.org/10.1007/s40726-024-00307-9.