Lecture 1. Nanomaterials. Carbon nanostructured materials. Properties.

The nanomaterials are classified based on materials used in the synthesis process, the origin of materials and based on the structure or dimension of nanomaterials. Based on the materials, nanomaterials can be classified to carbon-based, inorganic-based, organic-based, and composite-based. And based on the dimension criteria, nanomaterials can be divided into four categories: zero-dimensional, one-dimensional, two-dimensional, and three-dimensional.

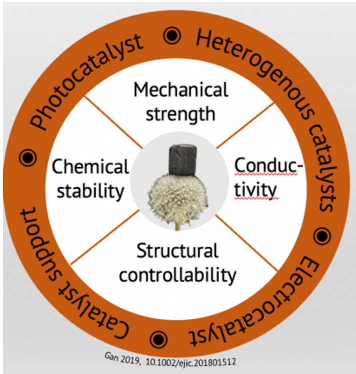
Carbon-based nanomaterial have attracted broad research interest for years, because of their diverse physicochemical properties and favourable attributes like good biocompatibility, unique optical properties, low cost, ecofriendliness, abundant functional groups, high stability, and electron mobility. An excellent photoluminescence properties of carbon dots offers great potential in sensing applications. Statistically, the usage of carbon dots in the sensor field is the most frequently reported in carbon dot applications. According to the various mechanisms carbon dot-based sensors can be divided mainly into photoluminescence, electroluminescence and electrochemical sensors. Luminescence sensors are mainly based on the quenching or preventing the quenching of carbon dots fluorescence emission in the presence of the analyte. Since Jin et al. first presented a graphene quantum dots-based photoluminescence sensor to detect Fe^{3+} ions in 2012, the "analyte" has been expanded to metal ions, hydrogen ions, anions, organic molecules, inorganic molecules, biomacromolecules and so on. Biomedicine is one of the most promising and frequently reported applications of carbon dots. They are safe for biomedical applications. Compared to traditional organic fluorophores and semiconductor quantum dots, *carbon dots* can be used in vivo/vitro by virtue of their photobleaching, highly selectivity, biocompatibility, and low cytotoxicity. *In vitro* cytotoxicity studies on a series of cell lines demonstrate the low toxicity or notoxicity and excellent biocompatibility of carbon dots even at a high concentration level. *In vivo* experiments indicate that carbon dots are rapidly excreted via the kidney and hepatobiliary system. Effectiveness and monitoring of the tumor-targeted therapy based on carbon dots in vivo are shown in this figure.

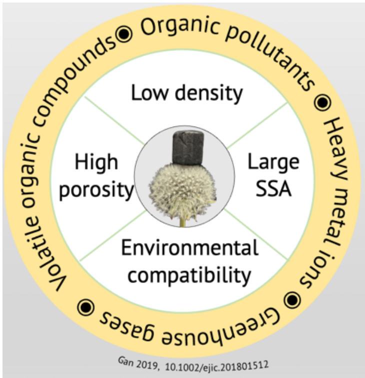
Carbon aerogels have generated interest over the last several decades due to their fascinating characteristics, which include tailorable structural and chemical properties, high porosity, low density, and working as a bridge between nanoscale to macroscale applications. Carbon aerogels are used in a wide range of applications including catalysis, gas storage, pollutant separation, thermal insulation, and energy storage.

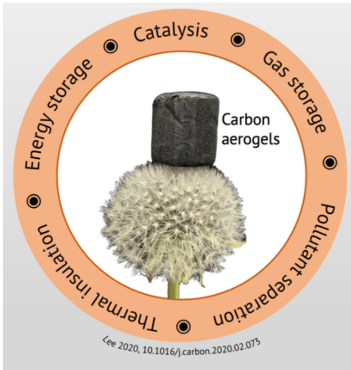
Carbon aerogels exhibit an attractive catalytic performance for the chemical degradation of the hazardous compounds. In this field, carbon aerogels are mainly exploited as an attractive catalyst or catalyst supports.

As an efficient catalyst, the interwoven network and high specific surface area of carbon aerogels could increase the number of active sites. Moreover, compared with other catalysts, carbon aerogels exhibit wonderful contaminant adsorption and enrichment capacity, which extremely enhances the catalytic performance. Therefore, carbon aerogels are frequently used as photocatalysts or electrocatalysts for pollutant removal in water or air. For aquatic environments, carbon aerogels are mainly used for organic pollutant oxidation and ion reduction.

The characteristics of large specific surface area, high porosity and adjustable surface chemistry endow carbon aerogels with excellent adsorption capacity. Therefore, they are widely used as attractive adsorbents. In environmental protection field, carbon aerogels have a good adsorption capacity for most of the mainstream pollutants.







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