Graphene-based materials for the fast adsorption of biomolecules

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Abstract
This study relates to hemoperfusion for extracorporeal blood purification and removal of inflammatory cytokines from human blood plasma in order to treat sepsis and related diseases. For this the blood plasma is perfused through a filter containing graphene-based sorbents. Graphene materials were chosen based on their open surface structure facilitating diffusion of the solutes to the surface and interlayer pore size, which is comparable to the size of the proteins to be adsorbed. Our results show that graphene nanoplatelets exhibit high adsorption capacity, but cannot be directly used in filtration due to the risk of small particles getting into the bloodstream. Granulation of this material using PTFE as a binder solves the problem of the particle release without reducing the open surface accessible for the protein molecules. Both materials produced a significant decrease of the target protein concentrations in blood plasma over a short period of time. These graphene-based adsorbents offer open hydrophobic surfaces fully accessible to proteins, which makes them suitable for use in filtration/adsorption devices for blood purification. Efficient removal of cytokines was shown using a specially designed recirculating flow system. Graphene nanoplatelets are among the fastest and most efficient sorbents identified to date; greatly outperform porous activated carbons and polymers also used in this application. This kind of graphitic adsorbent has a potential for treating of a broad range of conditions ranging from radiation sickness and drug overdose to Ebola, Crohn's disease, ankylosing spondylitis and other conditions related to excessive production of cytokines or toxic biomolecules in blood.