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Graphene fiber for the personal protection, and mitigating the nuclear and radiological accident consequences

Radioactive material dispersion and attacking nuclear facilities could be used for terrorism or other criminal acts. These incidents would lead to serious consequences such as human health and environment damage, creating panic, and affecting economic and political stability. Since 1993 to 31 December 2018, ITDB shows a total of 3497 incidents of unauthorized activities and events involving nuclear and other radioactive material, where 285 incidents were related to the illicit trafficking or malicious use [1]. These incidents lead to concerns of a possible radiological or nuclear terrorist attack.
Radiological terrorism using radiological dispersal device (RDD) is more likely to occur due to the relatively large number of commercially used radioactive materials and hundreds of nuclear facilities worldwide. With the increasing possibility of these incidents, the necessity of effective radionuclide adsorbing material is increased for the personal protection of the first responder as well as cleaning up radioactive materials and decontamination of buildings.
Graphene fiber could ensure the protection against gaseous radioactive elements and various chemical agents through the adsorption. Graphene-based materials have several benefits over currently used activated carbon such as large specific surface area up to ~3000 m2/g[2], high chemical/thermal stability, tunable specific surface area and pore structure, relatively low cost and easy scale-up associated with the manufacturing of the porous graphene carbons [3]. The high specific surface area of the graphene fiber increases the adsorption capacity. Different functionalized graphene fiber also could be capable to selectively adsorb different radioactive gases at various levels of relative humidity and conditions.
Various studies on graphene-based materials demonstrated the potential opportunities of graphene fiber for the use of personal protection through the adsorption of gaseous toxic elements. Anna Yu et.al shows the interaction of GO with actinides including Am (III), Th(IV), Pu(IV), Np(V), U(VI) and typical fission products Sr(II), Eu(III) and Tc(VII), along with their sorption kinetics [4]. Higher sorption affinity towards the toxic elements from different solution makes graphene oxide a promising new material for the radioactive nuclide removal and containment. Graphene-enhanced composite material GO/amidoxime hydrogel (AGH) shows the selective removal of uranium from aqueous solutions.[5]. In the case of CO2, H2, CH4 adsorption, the performance of graphene-based adsorbents is often higher, especially at high pressure [2][3]. Also, Graphene-based materials have potential opportunities for nuclear decommissioning [6].
This paper presents the effectiveness of graphene fiber as a potential sorbent of iodine (I2(g)). Also, the performance of silver functionalized graphene fiber is investigated, which would allow more selectively capture of iodine among other different elements. The graphene oxide fibers are produced through the wet spinning process using a coagulation bath of 5wt% CaCl2 into the solution of ethanol/water (1/3 v/v), which is shown in Fig.1. For the silver functionalized graphene fiber, silver nitrate (AgNO3) solution is added with the graphene oxide solution. Figure 2 shows the SEM images of the fabricated graphene oxide fiber and Ag functionalized graphene oxide fiber. The graphene fibers are exposed to a saturated iodine environment through the use of a desiccator, in which solid iodine crystals are placed. Iodine uptake is determined by the change in mass of the tested samples before and after exposure to the saturated iodine environment.

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