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Latest Progress in Black Phosphorus Nanoparticles for Cancer Therapy

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Abstract

Black phosphorus nanoparticles (BPNSs) have received considerable attentions for the cancer therapy due to their striking properties, such as a tunable direct bandgap, a favorable photothermal conversion efficient, hypotoxicity, excellent biodegradation and biocompatibility. BP is negatively charged in water. Due to the electron screening effect, BPNSs would easily aggregate and precipitate, especially in the presence of salts such as phosphatebuffered saline (PBS) and cell culture medium. Also BP has a lone pair of electrons, which are quite active, leading to its instability. But this property offers a tremendous advantage in terms of biodegradability. Usually researchers use polyethylene glycol-amine (PEG-NH_2) as a modifier of BP. But the high cost limits widespread use. So we choose chitosan as a counterpart to modify and stabilize BP. Chitosan is positively charged in acetic acid solution. So BP and chitosan have the possibility to be combined through electrostatic interaction. BP nanosheets with few-layers was dispersed in N-Methyl-2-pyrrolidone (NMP) organic solution. Then chitosan acetic acid solution was added into BP solution under sonication for 10 min; afterward, the BP solution was centrifuged for 5 min and resuspended in PBS. Prepared BP solution can stable existence for several days. Also we found that the temperature was increased by 15 °C for BP solution under 808 nm laser irradiation for 5 min. And BP can keep stable photothermal effect even after five cycles. So it has substantial potential for future photothermal clinical application. Also we successfully synthesized BP-Au NSs and BP-Ag NSs, which have the capability for surface-enhanced Raman scattering (SERS). By using these nanoparticles, Raman signal can be much stronger than before. But more effort should be made in the future for the early disease diagnostics.

Keywords: Black phosphorus; Nanoparticles; Cancer therapy