Carbon black as an outstanding and affordable nanomaterial for electrochemical (bio)sensor design

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Carbon is present in several allotropic forms ranging from graphite to diamond, till the most recently discovered fullerene, nanotubes, and graphene. The latter ones hold a leading role in the current electrochemical sensor scenario, thanks to their unique properties. The presence of carbon nanotubes or graphene on the surface of the working electrodes can improve the electroanalytical performances by enhancing the electron transfer at the surface of modified electrodes. In recent years, another interesting carbonaceous nanomaterial is becoming utterly interesting, due to its excellent conductive and electrocatalytic properties: Carbon Black (CB). CB is a form of amorphous carbon that has an extremely high surface area to volume ratio, and it has been one of the first nanomaterials for common use. In fact 70% of CB is used as a pigment and reinforcing phase in automobile tires. Few applications are reported in literature until 2010 using CB as sensing element for analyte detection in solution [1]. Herein, we present our results obtained in the last eight years with more than 20 publications on the use of CB as modifier for screen-printed electrodes towards several analytes including thiocholine, cysteine, NADH, hydrogen peroxide, free chlorine, tyrosine, and phenolic compounds. The high sensitivity of this nanomaterial for thiocholine was exploited to develop a chemosensor for Hg(II) and a biosensor for organophosphorus pesticide detection. The fouling resistance of CB was demonstrated for thiocholine as well as for the phophomolybdate complex. Moreover, the suitability of CB in electroanalysis was also explored preparing hybrid nanocomposites with gold nanoparticles for glucose, As(III) and Hg(II) detection, thionine for bisphenol A, cobalt(II) phthalocyanine for thiocholine and Prussian Blue nanoparticles for hydrogen peroxide. Furthermore, a direct comparison with SPE modified different types of carbon black as well as with graphene and carbon nanotubes, showed the advantages of CB for its electrochemical properties, cost-effectiveness, capability to easily obtain a stable and homogenous dispersion, demonstrating that CB can be widely employed in the development of nanomodified electrochemical sensors. Recently, we have successfully also used CB to assemble novel paper based electroanalytical tools for phosphate, ascorbic acid, buryrylcholinesterase, ethanol, glutathione, mustard chemical warfare agents, pesticides, and sodium ions.

References

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