Zirconium dioxide nanoparticles modified gold microelectrode for improved amperometric detection of ascorbic acid, 2,3-dihydroxybenzoic acid and pyrocatechol in flow-based analysis

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The modification of screen-printed gold microelectrodes (Au SPME) using zirconium dioxide nanoparticles (ZrO_2 NPs) and termed as Zr-Au SPME, has been investigated for improved amperometric detection (AD) in flow-based analysis. The average size of ZrO_2 NPs on Au SPME surface, calculated using a Gaussian distribution, was 22.5±7 nm. The redox behaviour of a test solute, ferrocyanide $[Fe(CN)_6]_{4-}$, on the bare-Au and Zr-Au SPME was initially investigated using cyclic voltammetry. The resulting voltammograms of the bare-Au and Zr-Au SPME were compared and the peak response (current) and effective surface area were 100% greater for the Zr-Au SPME. The AD performance of Zr-Au SPME was investigated for electroactive solutes in a standard LC platform. The limits of detection (LODs) of ascorbic acid, 2,3-dihydroxybenzoic acid and pyrocatechol were 0.09 μM, 0.04 μM, and 0.10 μM, respectively (RSD ~2.5 %, n=9, linearity r2 ~0.99 for concentration range 1-100 μM). LODs of electroactive solutes using Zr-Au SPME were 2–5 times lower than the lowest LODs reported in the existing literature using microelectrodes. Compared to reported AD in a standard LC platform a three times reduction of baseline noise and a 4–8% improvement in peak efficiency was achieved. The Zr-Au SPME demonstrated good repeatability and reproducibility, and a stability of approximately 8.5 hours in FIA and at least 45 days in a standard LC platform at 0.6 mL min-1.