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Determination and speciation of ultratrace arsenic and chromium species using aluminum oxide supported on graphene oxide

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Abstract

Alumina supported on graphene oxide (Al_2O_3/GO) nanocomposite as new nanosorbent in dispersive micro-solid phase extraction (DMSPE) for As(V) and Cr(III) preconcentration is described. The crucial issue of the study is synthesis of novel nanocomposite suitable for sorption of selected species of arsenic and chromium. Al_2O_3/GO demonstrates selectivity toward arsenates in the presence of arsenites at pH 5 and chromium(III) ions in the presence of chromate anions at pH 6. The Al_2O_3/GO nanocomposite was characterized by scanning electron microscopy (SEM) transmission electron microscopy (TEM), powder X-ray diffraction (XRD) and the Raman spectroscopy. The maximum adsorption capacity calculated based on the Langmuir adsorption model were 43.9 mg g^{-1} and 53.9 mg g^{-1} for As(V) and Cr(III), respectively. The nanocomposite was used as solid sorbent in preconcentration of As(V) and Cr(III)_ions from water samples and their determination using energy dispersive X-ray fluorescence spectrometry (EDXRF). The As(V) and Cr(III) ions can be quantitatively preconcentrated from 25-100 mL aqueous samples within 5 min using DMSPE procedure and 1 mg of Al_2O_3/GO. The nanocomposite was also used for preparation of Al_2O_3/GO membrane. Then, As(V) and Cr(III)_ions can be retained under flow condition by passing analyzed solution through Al_2O_3/GO membrane. Under the optimized conditions, As(V) and Cr(III) ions can be determined with very good recovery (92-108%), precision (RSD 2.7-4.0%) and excellent limit of detection (0.02 ng mL^{-1} As and 0.11 ng mL^{-1} Cr). The accuracy of the method was studied by analyzing certified reference materials (NIST 1640a) and spiked real water samples.

Graphical abstract