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Measurement of vanadium ultratraces in waters and leachates obtained of soils and sediments

Ignacio López-García (1), Juan Jose Marin-Hernandez (1), Manuel Hernandez-Cordoba (1), and Carmen Perez -Sirvent (2)

(1) Department of Analytical Chemistry, Faculty of Chemistry, Regional Campus of International Excellence "Campus Mare-Nostrum", University of Murcia, E-30100 Murcia, Spain, (2) Department of Agricultural Chemistry, Geology and Pedology. Faculty of Chemistry, Regional Campus of International Excellence "Campus Mare-Nostrum", University of Murcia, E-30100 Murcia, Spain

Vanadium is present at very low concentrations in the environment, foods and in the human body, where it plays an important role in different physiological processes. The element is essential for living organisms but, when its concentration exceeds a certain threshold, it may cause health problems. Due to its dual nature, the development of reliable procedures for the determination of vanadium is a subject of interest. Most of the procedures reported up-to-date for the purpose are based on atomic or expensive mass spectrometric techniques and, in many practical situations, due to the very low levels involved, close to the detection limit of any analytical technique used, a preconcentration stage is required. The literature reports a number of liquid-liquid microextraction methods for this purpose, including the use of surfactants, ionic liquids and organic solvents. Solid-phase microextraction approaches have been also proposed, although less frequently.

In this communication, a study regarding the affinity of V(V) and V(IV) towards graphene oxide (GO), which results in a complete retention of the vanadium species is presented. Graphene oxide is obtained by oxidizing graphite, and has oxygen-containing functional groups that favors the retention of polar species. The hydrophilic and hydrophobic characteristics of GO indicate that this material could be incorporated in the micelles obtained when a cloud point microextraction (CPE) technique is carried out, and this is the approach here followed to develop a procedure for the determination of the extremely low concentrations of this element present in waters and leachates obtained of soils and sediments.

The final optimized analytical procedure involves the use of GO to retain the vanadium species, while the dispersed nanoparticles are collected by means of a CPE process. In this way, separation by centrifugation is facilitated, and a high enrichment factor is achieved. Since a low volume of coacervate is involved, electrothermal atomic absorption spectrometry (ETAAS) is an excellent technique for the final measurements to be carried out. The combination of the separation stage with the sensitivity inherent to ETAAS results in a highly sensitive procedure for vanadium determination without the need for an expensive ICP-MS instrument. In addition, since both oxidation degrees of vanadium (pentavalent and tetravalent forms) are separated with the nanoparticles, a non-chromatographic speciation can be carried out at very low levels. The reliability of the procedure is confirmed by analyzing a number of waters with certified vanadium content.