The assembly of the nanoparticle-based assays with automatic flow sytems: potentialities and limitations

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Abstract

Nanotechnology constitutes an appealing and pursued research area which has already demonstrated its potential in numerous and varied applications. A core piece of this technology is the use of nanomaterials ranging from industrial, chemical, medical, to environmental fields. Among the nanomaterials, nanoparticles (NPs) have a number of key properties that make them particularly attractive in different formats, such as when used as quantitation tags, acting as analytical signal catalysts, in the analyte recognition and scavenging/separation, or when functionalized to carry out specific functions, especially in the biomedical field.

The idea of assembling the NPs with flow management approaches seems to be advantageous since it permits confined, precise, rigorous and reliable analysis within a shorter timeframe, besides allowing to take advantage of the particular features of the NPs, such as their unique electrical, optical and magnetic properties, high adsorption capacity and target compounds binding ability. In fact, these approaches enable a precise control of the reaction environment and of the constituent reaction steps, being adequate for the implementation of complex reactional schemes or multiparametric determinations, and guarantee that the consumption of expensive or toxic reactants is minimized and the subsequent waste generation.

This communication is intended to review the state-of-the-art of flowing stream systems comprising NPs as analytical tools, with different chemical nature, like noble metals (gold and silver), magnetic materials, carbon, silica or quantum dots. Particular emphasis will be dedicated to the categorization of the NPs-based assays in the different flow strategies, namely flow injection analysis (FIA) [1] and sequential injection analysis (SIA) [2], where the most representative applications will be selected and the main achievements and limitations will be discussed. Furthermore, it will be envisaged possible future trends of the analytical potential of NPs focusing on their use in automated flow-based approaches.

The ease of implementation of these NPs-based assays in the flow systems, by the use of readily-available equipment, less expensive instruments and by coupling usual detection systems found in most laboratories, and the rigorous and exquisite control of the reaction environment conditions attained in these closed systems open clearly new avenues to expand the knowledge about the NPs synthesis and reactivity and thereby to fully exploit the tremendous analytical potential of nanoparticles in conventional and novel application fields.

[1] J. Ruzicka, H. Hansen, Analytica Chimica Acta, **78** (1975) 145–157.

[2] J. Ruzicka, G.D. Marshall, Analytica Chimica Acta, **237** (1990) 329–343.