Quantification of Nanoparticles used in Biomedical Applications via Total Reflection X-ray Fluorescence

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The interest in using nanoparticles for various biomedical applications has increased greatly in recent years. The similarity in their size relative to biological molecules, their biocompatibility, as well as their unique and customizable optical, physical and magnetic properties makes them attractive for medical applications.[1,2] They are currently being investigated for use in various medical imaging and therapy applications, as well as for targeted drug delivery. [1,2]

Further advancement in the medical application of nanoparticles requires quantitative studies on cellular uptake. [1] This is necessary for investigating cellular toxicity as well as advancing their imaging and therapeutic applications. One of the major challenges with such applications is quantifying elemental concentrations in cell cultures given their very low concentrations and very small sample volumes.

This work describes a total reflection X-ray fluorescence spectrometry (TXRF)-based method for the quantification of metals, in the form of ionic digests and as native solid nanoparticles, in very small sample volumes when present in low concentrations. The spectrometer employs a molybdenum target X-ray tube (monochromatic at 17.5 keV), a SDD detection system and the use of high purity quartz reflectors as sample carriers (S2 PicoFox, Bruker-AXS, USA). This spectrometer uses small sample volumes (i.e. 1 µL), with minimal sample pre-treatment. Quantification can be performed against suitable internal standards, and/or combinations thereof, which allow for multi-elemental quantification.

This work investigates a TXRF-based method for the quantification of metals used in nanomedicine, namely: gold, platinum, silver and gadolinium. Given that an SDD detection system is employed, this generally necessitates the use of the L-series for quantitative purposes. Recovery rates obtained using suitable internal standards, detection limits, variety of peak deconvolution and fitting approaches (particularly those suited for L-series deconvolution) as well as challenges with sample preparation will be presented.

References
