Detecting and Measuring Nanoparticles in Complex Matrices: the SMART-NANO Platform

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We report on the final integration of the complete SMART-NANO technology platform, which was developed to detect and characterize nanoparticles in various complex matrices, such as cosmetic products. The platform was shown to fulfill the performance requirements in four key application fields, while reducing cost, ecological impact and time required for the analysis of complex nanoparticle-containing samples

The current European regulations on cosmetic products and food require all ingredients present in the form of nanomaterials to be clearly indicated as such. Such a clear statement implies the need for comprehensive analytical procedures to thoroughly check the compliance of any manufacturer with these regulations. The analysis of nanoparticles in complex multicomponent media, such as emulsion-based cosmetic products, is however a complex process requiring several steps, including sample pre-treatment, the separation of the engineered nanoparticles (ENPs) from their matrix, and so on. The most pressing research needs hereby are the development of new analytical techniques for nanoparticle extraction, cleanup and separation, which should ideally improve the speed, sensitivity and specificity of the downstream analytical methods.

The project SMART-NANO tackled this complex needs by developing an innovative, cost-effective technology platform providing a total solution "from sample-to-result" for the detection, identification, and characterization of engineered nanoparticles (ENPs) in a wide range of matrices. The technology platform is based on a modular and scalable approach, which gives the flexibility to adapt towards new applications with minimal optimization. Four key application fields (Consumer Products, Food, Environment and Biota) were targeted through the development of specific ENP-containing model kits. Parallel to the development of the technology platform, a range of miniaturized, ready-to-use, cost-effective cartridges were developed, together with corresponding analytical protocols.

Previously, we reported on the development of a novel sample preparation method, the miniaturization of the employed particle separation cartridge, as well as the implementation of new UV absorption and Multi-Angle Light Scattering (MALS) prototype systems (see CSEM Scientific Reports 2012 – 2015). In the last year, all of those components were combined into the SMART-NANO technology platform (shown in Figure 1) and the new setup was extensively tested using ENP-containing kits specifically developed for the four application fields. These tests proved the efficacy of the SMART-NANO platform in detecting and characterizing ENPs in complex matrices, demonstrating significant advantages over currently used techniques. Key innovations introduced by SMART-NANO include the use of inverse supercritical fluid extraction for the treatment of ENP-containing samples, as well as miniaturized, disposable cartridges for flow-field-flow fractionation. Overall, the benchmarking of the SMART-NANO platform confirmed that the platform fulfils the requirements of the application fields in terms of all analyzed parameters (accuracy, reliability, size, sensitivity, repeatability, linearity, LoD and LoQ), while reducing cost, ecological impact and time required for the analysis of complex ENP-containing samples. Most importantly, the presence of nanoparticles in complex samples could be unequivocally demonstrated, and accurate size distribution could be obtained in the vast majority of samples, including the highly relevant case of cosmetic creams.

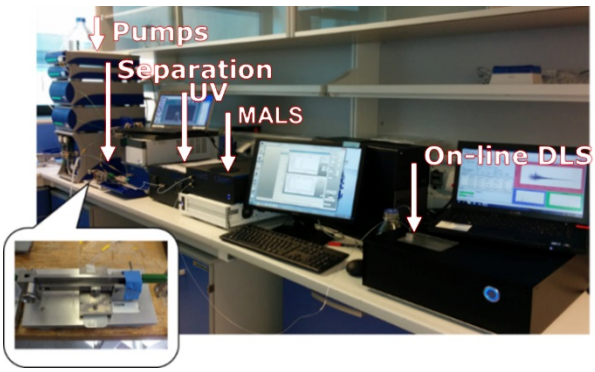

Figure 1: The complete SMART-NANO technology platform, incorporating all the newly developed sample treatment and analysis modules.

The SMART-NANO consortium was formed by 8 partners (3 academia and 5 SME's) from 8 different countries and led by CSEM as the project coordinator. The balance between industrial and academic partners was one of the key strengths of the project, ensuring the alignment between research efforts and industrial requirements. The results of the SMART-NANO project led to several publications in leading scientific journals and conference presentations. The commercial exploitation of the results has already started with the commercialization of key components of the platform, and will continue with the development of a fully integrated system in the following years.

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