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Multidimensional Assessment of Polymer Nanoparticles

Joshka Verduin[1,2], Jordy Kruijswijk[1,2], Kevin Jooss[1,2], Tijmen Bos[2,3], Bob W.J. Pirok[2,3], Govert W. Somsen[1,2]
[1]Vrije Universiteit Amsterdam, Amsterdam, Netherlands, g.w.somsen@vu.nl
[2]Centre for Analytical Sciences Amsterdam (CASA), Amsterdam, The Netherlands
[3]University of Amsterdam, Amsterdam, The Netherlands

Summary

Polymer nanoparticles (NPs) are increasingly utilized for multiple purposes. For instance, polymer NPs are key constituents of advanced paints and coatings, and are used as sophisticated carriers for new therapeutic agents. NP dimensions such as size, chemical content, and charge strongly determine the overall quality and end-product properties. These characteristics need to be assessed analytically, which can be quite challenging.

We developed a comprehensive online two-dimensional liquid chromatography system that is capable of determining both NP size and encapsulated cargo using one integrated method [1]. Hydrodynamic chromatography (HDC) was used in the first dimension to separate the intact NPs and to determine the particle-size distribution. Fractions from the first dimension were taken comprehensively and the NPS were disassembled online, releasing their payload. Reversed-phase liquid chromatography (RPLC) was used as a second dimension separation to analyze the quantity, quality and stability of the cargo molecules as function of NP-size distribution.

For the determination of the surface charge of NPs, we employed capillary electrophoretic (CE) principles. Experimentally acquired electrophoretic mobilities (EMs) of NPs, were transformed into NP zeta potentials and, subsequently, into surface-charge densities (SCDs) using appropriate theoretical models. We developed a suitable CE method using well-defined polystyrene NPs as benchmarking compounds, taking the effect of NP size and size distribution on obtained EMs into account. We used CE for the assessment of SCDs of several new industrial copolymer NPs varying in acidic monomer content. CE results revealed that the CSD of some NPs was not only determined by chemical composition, but also by the (previously unknown) presence of adsorptive species such as surfactants.

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References

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