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# Accurate measurement of refractive index of individual spherical particles from angle-resolved light scattering

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Considering various applications of light scattering in particle characterization and remote sensing, the refractive index (RI) serves as significant particle characteristic. For instance, being related to the chemical composition of the particle, RI may be used to identify different subpopulations of particles in polydisperse samples. At the same time, most characterization techniques treat RI as a secondary quantity in comparison with size and shape. RI is either assumed to be known a priori (or measured independently) or its measurement precision is relatively bad due to insufficient amount of measured scattering data. Real-time high-throughput techniques capable to accurately measure RI of single particles of different shape and nature in monodisperse and polydisperse samples, including inorganic particles or particles of biological origin, are lacking. Here we present an accurate and effective method for the determination of the RI and size of an individual spherical particles from angle-resolved light scattering.

Angle-resolved light scattering patterns (LSPs) of individual particles in flow are measured by a scanning flow cytometer (SFC). Additional light-scattering data from side scattering (SSC) measured using a different wavelength is used to improve the accuracy of particle characterization. Characterization of spherical particles by their RI and size including uncertainties of these estimates is performed by solving the inverse light-scattering (ILS) problem using Mie theory for light-scattering simulation and global optimization for simultaneous fitting of experimental LSPs and SSC signals by theoretical ones.

The method has been applied to measure RI of different objects in monodisperse and polydisperse samples, including polystyrene microspheres of different sizes, milk fat globules and blood plasma cell-derived microparticles. In particular, RI of polystyrene microspheres was determined as 1.616-1.618 at wavelength 405 nm, that agrees with literature data for bulk polystyrene. Median uncertainty for individual particle RI measurement was as small as 0.003. Moreover, the size of single microspheres from 0.4 to 2 $\mu$m was determined with median uncertainties from 8 to 20 nm, respectively.

Thus we developed and demonstrated a high-speed flow-cytometry technique for the accurate measurement of the refractive index of individual micron and submicron spherical particles of different nature constituting monodisperse and polydisperse samples. Measured RI may serve either as characteristic property of the studied objects or as reference values for light-scattering simulations performed in other studies.