Characterization of aquatic nano-particles (colloids) using Nano-Particle Analyzer on basis of Laser-induced Breakdown Detection

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Colloids are omnipresent, be it in nature, in biotechnology, in medicine, in industry or in agriculture. Colloids are defined as very small particles in the nanometer range, from app. 1 nm to 1,000 nm. Due to their small sizes colloids have a large surface in comparison to their mass and therefore a big sorption capacity. That's the reason for the capability to stabilize substances/pollutants beyond their thermodynamic solubility. On the other hand, nano-particles represent unwanted and difficult to detect particular contaminants that reduce the product quality in many areas of the modern production technology, e.g. in semiconductor or pharmaceutical industry. In addition, colloids can be of biological nature like bacteria ore viruses and have a crucial influence on the quality of the most important nutrient, drinking water.

Quantification of aquatic colloids is associated with many difficulties, because they are often found in low concentrations with a particle size distribution where the smallest colloids below 100 nm in diameter predominate.

The principle of the Nano-Particle Analyzer (NPA) on basis of Laser-induced Breakdown Detection (LIBD) is the generation and counting of plasma events on colloidal particles into liquid media. Due to the fact that the breakdown threshold (laser pulse power density which is necessary for plasma generation) is lowest for solids, breakdowns can be produced selectively on solids (colloids) in liquids. The laser energy is reduced so that no breakdown event happens in the pure liquid (water) but on the solid particulate matter. The number of plasma events per number of laser pulses is defined as breakdown probability and depends on both particle concentration and size. To determine the size a sufficient number of plasma events are optically detected by an image processing system. The distribution of this plasma events in the focal volume of the focused laser beam depends directly on the particle size and is independent of the concentration. With known particle size and breakdown probability a colloid concentration can be calculated.

The main advantage of NPA/LIBD in comparison to conventional methods for colloid analysis is the much higher sensitivity for particle detection, especially in the region of small colloids below app. 500 nm. Thus it was found that the limits of detection are up to 1,000,000 times lower than for the laser light scattering method PCS (Photon Correlation Spectroscopy).