

Laser-induced breakdown detection/spectroscopy (LIBD/S): Methods for the direct analysis of aquatic colloids

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The effect of colloids on the migration of pollutants is of major concern in environmental research. Colloids are present in all aquatic systems, they have a high specific surface to mass ratio. Therefore colloids have a high capacity for sorption of pollutants. Sorption of contaminants on colloid surfaces is a mechanism to be regarded for the prediction of the migration behavior of hazardous substances. Formation of colloidal species of toxics enhance the stability of e.g. heavy metals over their thermodynamic solubility. In addition, colloids can interfere with disinfection during water purification for drinking water production and provide a medium for microbial growth. Colloids may indicate the presence of disease-causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches. Viruses in particular show a size spectrum down to only a few 10s of nm. Therefore the number density and the size distribution of colloids in environmental relevant low concentrations and the elemental compositions of these nano particles is essential information. Additionally, for prediction of solubility data the detection of colloids in the lower part of the nano meter range is fundamental.

The laser-induced breakdown detection (LIBD) is a sensitive nano particle analyzing method for the direct detection of colloids. During the detection process plasmas are generated on single particles by a focused laser beam and the produced plasma light emissions are detected. The LIBD is based on the difference in the breakdown thresholds of liquid and solid matter. The laser beam energy is attenuated as much that in the pure liquid no breakdown events occur, and only in the presence of colloidal particles the breakdown threshold in the focal volume is exceeded. The evaluation of the number of breakdown events per number of laser shots results in a breakdown probability, dependent on particle concentration and size. For the determination of colloid sizes the light emission of single plasmas are detected by a microscope CCD-camera system. The optical spatially resolved detection of the plasma light emissions results in a spatial distribution of breakdown events within the focal volume, dependent on particle size and not dependent on concentration. With known mean particle diameter and breakdown probability the particle concentration can be calculated.

The second part of the present work is directed toward the selective analytical application of laser-induced breakdown spectroscopy (LIBS) for colloidal particles in aqueous solution. LIBS is based on atomic emission from a plasma spark which is produced by focussing a laser pulse. The light emission is collected into a Czerny-Turner spectrograph combined with an intensified CCD camera by which emission spectra are recorded. It is to mention that this analytical tool allows the qualitative and quantitative particle analysis without artifact by possibly other contaminants, unfortunately detection limits are rather poor compared to today's standards or LIBD.