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Initial stages of immunoagglutination studied with the adaptive polarization nephelometry

A.A. Polshchitsin (1,2), M.A. Yurkin (1,2), V.P. Maltsev (1,2,3)

(1) Voevodsky Institute of Chemical Kinetics and Combustion SB RAS, Novosibirsk, Russia, (2) Novosibirsk State University, Novosibirsk, Russia, (3) Novosibirsk State Medical University, Novosibirsk, Russia

Aggregation of microscopic objects into clusters is a widespread phenomenon, which takes place in different areas of physics, chemistry, biology and medicine. Such biological processes as thrombus formation, bacteria clumping, polymer particles agglutination are typical examples of the colloid aggregation. Investigations of the aggregation kinetics are important for understanding of examined sample evolution and for characterization of individual objects properties. The classical methods for aggregation kinetics measurement are based on light scattering. Turbidimetry and nephelometry are the most abundant techniques among them because of relative cheapness and ease of use.

This work is devoted to the development of the adaptive polarization nephelometric method for the investigation of initial stages of monodisperse polymer spheres aggregation. The method differs from the classical ones by enhanced sensitivity, accounting for polarization effects, and possibility to adjust the angle of light scattering detection depending on the application. On the basis of simple optical elements we have proposed an instrument with the following key features: 1. there is no signal on the detector when the examined mixture contains only monomers; 2. the signal for dimers (bispheres) is the maximum among all scattering angles (optimization is performed by theoretical calculations via superposition T-matrix method).

As a starting idea we considered a simple combination of crossed linear polarizers before and after the optical cell, which allows one to measure the M22−M11 combination of Mueller matrix elements. This combination is zero for spherical objects and nonzero for orientationally-averaged nonspherical ones (e.g., bispheres). The only parameter to optimize (to maximize the signal) is then the angle of scattered light detection.

We also studied opportunities presented by other combinations of Mueller matrix elements, which may become relevant for larger particles. Since the rotational diffusion period for dimers of such particles can be larger than the standard PMT signal registration time, the conditions for orientation averaging is not necessarily satisfied in certain experimental environment. In particular, this is achieved by reducing the amount of dimers within the measurement volume.

Thus, in this work we present the method of adaptive polarization nephelometry for the investigation of initial stages of spherical objects agglutination. It contains theoretical estimations for different particle sizes and experimental data.