Reverse microemulsions with silver and gold nanoparticles and high water content

Popovetskiy P.S., Bulavchenko A.I., Demidova M.G., Podlipskaya T.Yu.

Nikolaev Institute of inorganic chemistry
Siberian branch of Russian academy of sciences, Novosibirsk, Russia

popovetskiy@niic.nsc.ru

Microemulsion synthesis is the widely used method of nanosized particles producing, in particular noble metals nanoparticles. Concentrated reverse microemulsions are promising in various fields of microelectronics and hi-tech production, such as e-ink and metal-based inkjet inks. Corrosion resistance and high surface charge to size ratio of the sol particles result in their aggregation stability. Microemulsions based on ionic surfactants with high water content (more than 10% vol.) are especially interesting due to percolation processes. Reverse micelles self-assembly, resulted in elongated channels formation, leads to a sharp increase in the electrical conductivity of the system. Nevertheless, the water content typically used for nanoparticles preparation does not exceed about 1% (at higher water contents coagulation take place), which imposes some restrictions for high concentrated organosols preparation.

We have developed an electrophoretic method for highly concentrated silver and gold organosols preparation (metal content up to 2M). Stable system from nanoparticles in surfactant matrix is obtained by the concentrate drying. This system contains no admixtures of reductant excess or nanoparticles synthesis by-products. The resulting composite is used for preparation of new microemulsion with nanoparticles and high water content (more than 20% vol.; note that it is not possible to obtain stable microemulsions with such water content without any concentration and purification procedures). The structure of nanoparticles in microemulsions is analyzed by a complex of colloid-chemical methods (dynamic and static light scattering, phase analysis light scattering, nonaqueous electrophoresis, spectrophotometry, electron microscopy, X-ray diffraction, viscometry and others).

It is shown that the nanoparticles have a monolayer structure of the adsorbed layer only at low surfactant concentrations. At high concentrations (>0.1 M) it becomes polylayer because of surfactant micelles adsorption. Organic solvent polarity increasing, surfactant concentration increasing and temperature reduction has been resulted in the adsorption layer thickness Increase.

The observed effects were explained by increasing of the electrostatic interaction energy between nanoparticles and charged micelles using Debye-Hückel theory.

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