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THE COMPARATIVE CHARACTERIZATION OF DNA:TiO_2 NANOPARTICLE AND DNA:MoS_2 NANOPARTICLE NANOASSEMBLIES COLLOIDAL SOLUTIONS INVESTIGATED BY DYNAMIC LIGHT SCATTERING METHOD

Sviderska A.Yu.[1*], Valeev V.A.[1], Lahuta A.N.[2, 3], Petrushenko S.I.[2], Glamazda A.Yu.[1], and Karachevtsev V.A.[1]
[1] *B.I. Verkin Institute for Low Temperature Physics and Engeneering, National Academy of Sciences of Ukraine,*
[2] *V.N. Karazin Kharkiv National University,*
[3] *Aston University, Birmingham, UK*
Corresponding author: sviderska@ilt.kharkov.ua

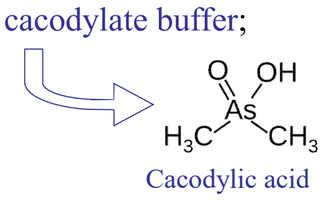
The present work is dedicated to compare of nanopaticle (NP) size and temperature stability characteristic of three different colloidal solutions contained DNA and inorganic nanoparticles (NPs). As a method the dynamic light scattering (DLS) measurements were performed in the temperature range of 25–90^{0}C in the cacodylate buffer. It seems reasonable that we need used the DLS size distribution by number.

The study of the present problems is caused by the necessity of the forecasting of the absorption processes efficiency on biopolymer-covered TiO_2 or MoS_2 nanoparticles.

Nanoobjects for dynamic light scattering investigation

DNA : TiO_2 NPs nanoassemblies

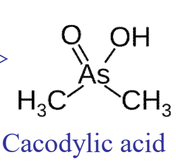
Aqueous colloidal solution with:
[c_{TiO2}] = 1.5×10^{-4} M;
pH 5 or pH 7 with the cacodylate buffer;
I = 0.1 M (Na^+);
c(DNA)$_P$ = 8×10^{-5} M.



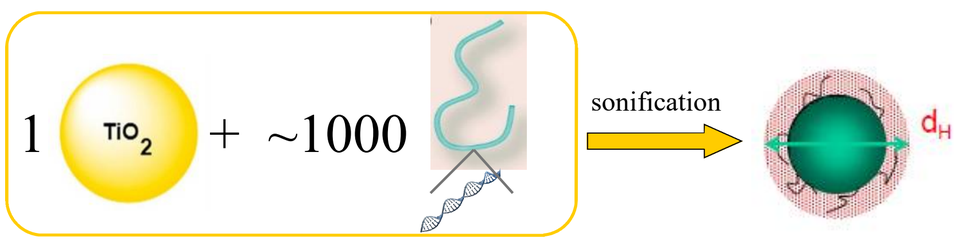
Cacodylic acid

DNA : MoS_2 NPs nanoassemblies

Aqueous colloidal solution with:
[c_{MoS2}] = 1 μg /ml;
pH 7 with the cacodylate buffer;
I = 0.001 M (Na^+);
c(DNA)$_P$ = 9.182×10^{-5} M.



Cacodylic acid



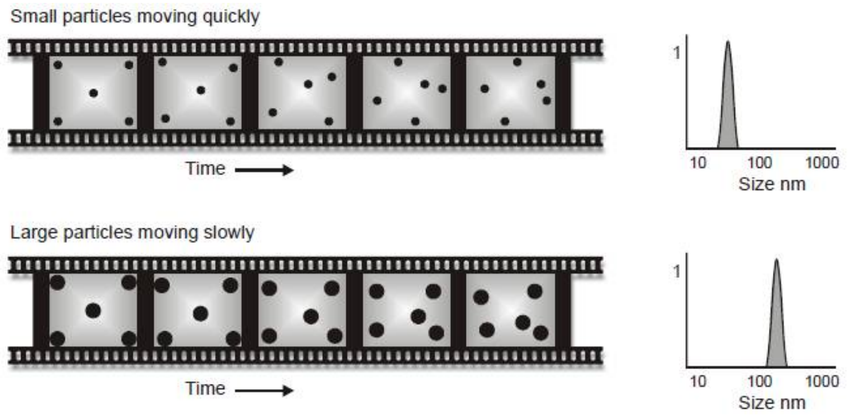
3.3×10^{12} ***TiO_2 NP/ l*** 3.5×10^{15} ***DNA/ l*** ζ = – 49.2 ± 0.8 mV

Dynamic light scattering method

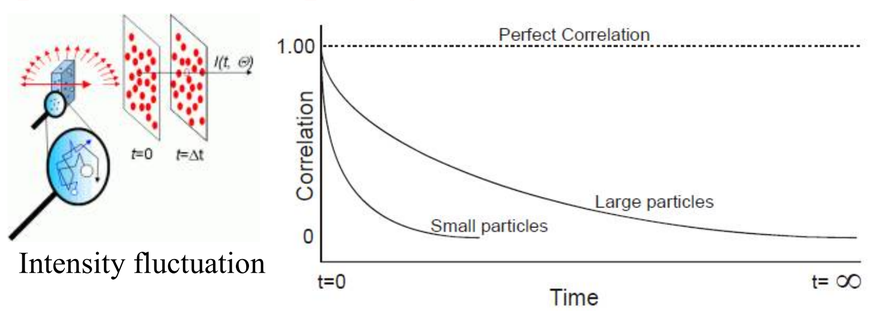
Malvern Zetasizer Nano ZS (Red badge) ZEN3600

The particle size measured in a **D**ynamic **L**ight **S**cattering (**DLS**) instrument is the diameter of the sphere that diffuses at the same speed as the particle being measured.

Brownian motion
“The random movement of particles in a liquid due to the bombardment by the molecules that surround them”

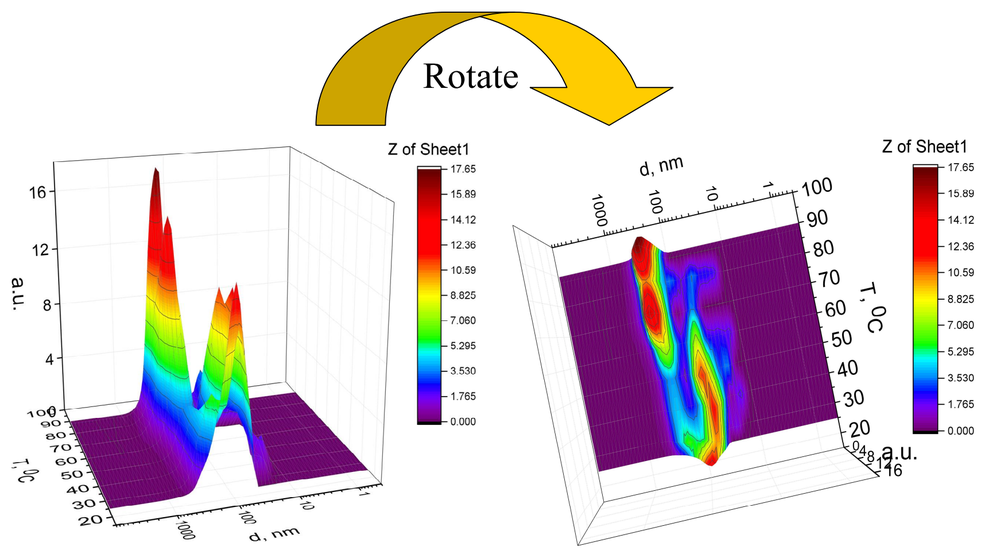


Large particles move slowly, while smaller particles move quickly.



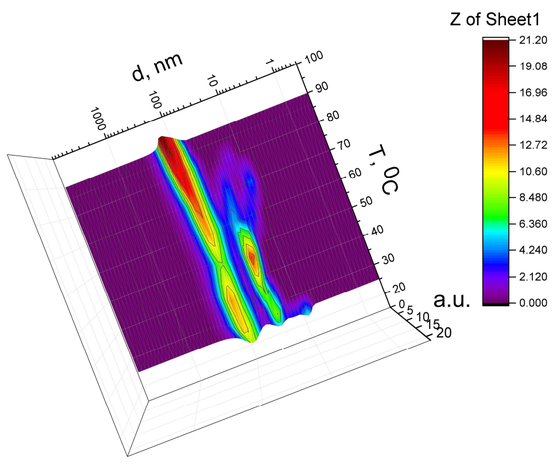
I. DNA:TiO_2 NPs nanoassemblies, pH 5

DLS distribution by number: what happened?



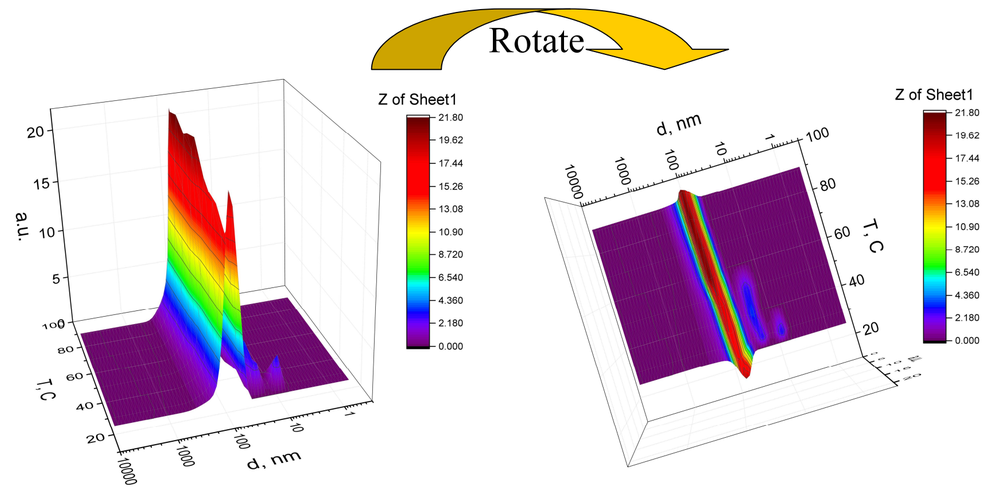
When temperature increases up to 90^{0}C there are more particles with average diameter of about 200 nm and more (up to 500 nm). *At the temperature of about 60^{0}C the surface of map „turns into” larger particles – nanoaggregates of nanoassemblies.* The performed spectroscopic studies of the temperature stability of the biopolymer revealed that upon heating, the DNA denaturation begins from about 75^{0}C. We suppose that the partial denaturation of the DNA bound to TiO_2 NPs surface leads to appearance of untwisted strands which capture the neighboring assemblies. This leads to formation of larger DNA:TiO_2 nanoaggregates which can consist of more than one TiO_2 NP or more DNA molecules are associated with TiO_2 NPs. The number-based average diameter of the DNA:TiO_2 NP nanoggregates is of about 80 nm at 25^{0}C and of about 210 nm at 90^{0}C.

II. DNA:TiO_2 NPs nanoassemblies, pH 7



In the case of pH 7.0 the distribution by number for DNA:TiO_2 NP nanoassemblies system is different. The number-based average diameter of the DNA:TiO_2 NP nanoassemblies is ~ 100 nm at 25 ^{0}C and ~ 110 nm at 90 ^{0}C. There are observed minor peaks (~ 20 nm) but the main peak looks similar to that one for pure TiO_2 NP and DNA:TiO_2 NP nanoassemblies (pH 5.0) colloidal solutions at 25 ^{0}C. *So, at pH 7.0 we didn’t observed formation of larger nanoaggregates as in the case of pH 5.0.* In turn it may be related to strong binding of DNA macromolecules to TiO_2 NPs.

III. DNA:MoS_2 NPs nanoassemblies, pH 7



As regards DNA:MoS_2 NPs nanoassemblies colloidal solution at pH 7.0, the number-based average diameter of the DNA:MoS_2 NP nanoassemblies is of about 90 nm in all temperature range. *So, for this system at pH 7.0 we didn’t observed larger nanoaggregates.*