Dispersing and stabilization of carbon black with CTAB

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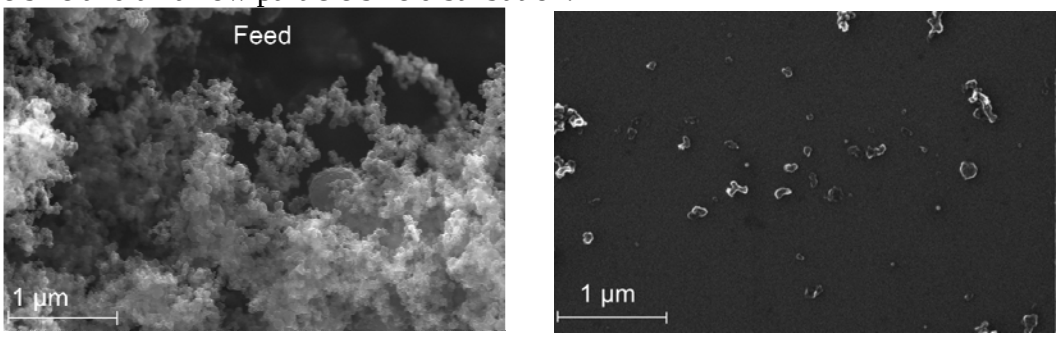
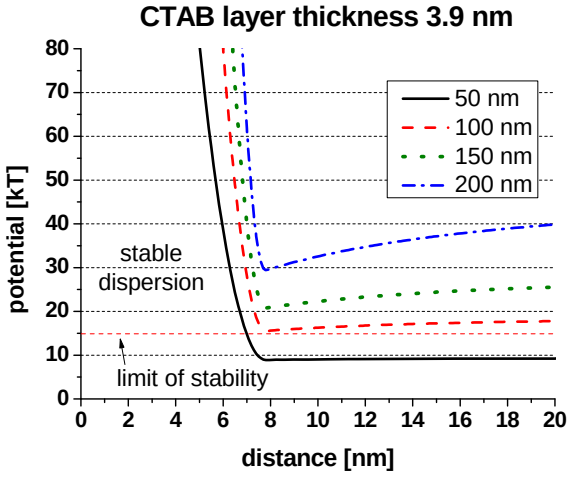
The preparation of stable carbon black suspensions is an important step in the process chain for manufacturing pigments, rubbers, fillers and catalyst layers. We study the dispersing behaviour of carbon particles with N, N, N-Cetyltrimethylammoniumbromide (CTAB) in water in detail in order to get a better understanding for parameters governing the dispersion and agglomeration behaviour of the particles. The concentration of the stabilizing agent as well as the grinding conditions are optimized in order to achieve a minimization of the particle size and a narrow particle size distribution.



SEM images: feed material carbon black (left); after dispersing in water (CTAB) in a batch mill (right)

To analyse the dispersions regarding their particle sizes, static and dynamic light scattering were done and volume averaged particle diameters of about 100 nm were found. The stabilizer still remains on the surface after different washing and centrifugation cycles. The stabilization mechanism was studied with thermogravimetric analyses and nitrogen absorption to calculate the relation between increasing specific surface area and adsorbed amount of adsorbed CTAB.
Due to a constant relation of the amount of stabilizer on the particle surface the coverage in the beginning is the same as in the milled dispersion. Calculating the area one CTAB molecule occupies results in a monolayer of the stabilizer after the washing steps.



Extended DLVO calculations (carbon black particles + CTAB): smaller particle diameter → smaller repulsion → instability (potential < 15kT)

In addition, the adsorbed layer is studied in the liquid – by using AFM and ellipsometry to investigate not only the dried CTAB layer, but also the interactions of the molecules on the carbon black surface with water, too. At CTAB concentrations higher than the cmc (used for the experiments) not only a monolayer (calculated from the dried powder analysis) was detected, but ellipsometry showed a second adsorption step. Furthermore interaction potentials were calculated by an extended DLVO-theory. For the polymeric interactions, we used a concept based on Hansen interaction parameters. The results of the stability calculations confirm the experimentally found stabilities. With smaller particle diameters the repulsion decreases more than the absolute attraction force and indicates an instable dispersion beyond the stabilization distance (8nm).