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Structural Charge Determination on Tartrated Magnetic Nanocolloids

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Abstract – Functionalized magnetic fluids (F-MF) are synthesized from conventional EDL-MF through the chemiosorption of appropriate ligands on particle surface. Since these chemical designed nanomateriais can be stabilized in biological environments, they have been used as promising biomedical technologies. In this work, it is focused the surface charging process of tartrated functionalized magnetic fluids by using simultaneous potentiometric-conductimetric measurements. The results allow the nanoparticles structural charge determination in excellent agreement with reported values.

Electric double layered magnetic fluids (EDL-MF) are water based nanocolloids of spinel ferrite type nanoparticles. According to the Two-pK Model, in acidic medium the nanoparticles are positively charged while in alkaline region they present a negatively charged surface. In biological buffers, close to the neutral medium, the EDL-MF nanoparticles surface charge tends to zero which induces rapid coagulation of the colloidal system. In this way, for biotechnological applications the conventional EDL-MF must be designed with biocompatible stabilizers in order to obtain a longer colloidal sol phase in physiological pH. This process is achieved through the chemiosorption of appropriate ligands on nanoparticles surface leading to a functionalized magnetic fluid (F-MF). Among the numerous types of chemical ligands of potential interest, the tartrate provides a colloidal stability domain in pH region between 4 and 10. In this context, the aim of this work is to characterize the surface charging process of tartrated functionalized magnetic colloids through an electrochemical approach established by our group [1].

Figure 1 exhibits the titration curve for the alkaline F-MF based on tartrate-functionalized nanoparticles ($CoFe_2O_4$) with mean size d_{XR} = 14.3 nm and volume fraction ϕ = 1.09 %. As it can be seen, the curve reveals three different regions defined by the equivalence points. The first region corresponds to the OH^- free ions neutralization in the bulk dispersion and the third one is related to the titrant excess. The second region is associated to the functionalized particle surface and the free tartrate ions. The concentration of the latter was obtained from a calibration curve method.

The nanoparticles structural charge (σ_0) and the pK were calculated according to reference 1 for EDL-MF and F-MF samples. In this case, as the functionalized-surface behaves as a monofunctional Brönsted base it was used the One-pK Model for the F-MF. The results were found σ = 0,35 ± 0,07 $C.m^{-2}$ (to both EDL-MF and F-MF) and pK = 9,49 ± 0,47 to F-MF in excellent agreement with the reported values [2].

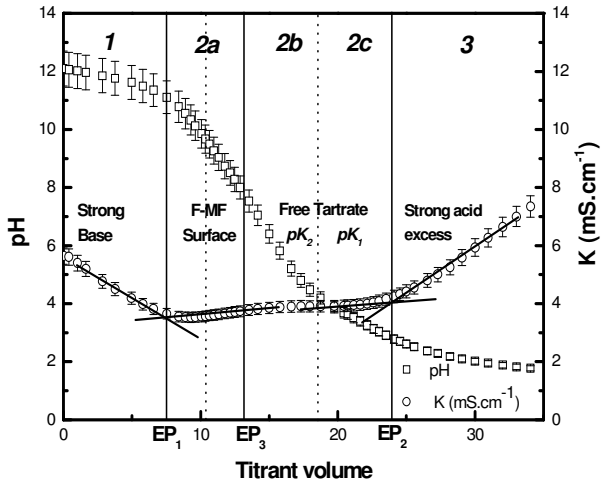

Figure 1: Potentiometric-conductimetric titration curve of F-MF samples. EP_1, EP_2 and EP_3 are the equivalence points.

References

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