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Electric response of a magnetic colloid to periodic external excitation for different nanoparticles concentrations: Determination of the particles' effective charge

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ABSTRACT

The effective electric charge of a nanoparticle in an ionic magnetic colloidal system (an ionic ferrofluid) is determined by using the impedance spectroscopy technique. The electric response of the samples to a harmonic external electric field excitation is described by means of the Poisson-Nernst-Planck model. The model proposed for the theoretical interpretation of the impedance spectroscopy data considers that the magnetic particles are electrically charged with H^+ and have in their vicinity Cl^- counterions, resulting in an effective charge Q_{eff} . In the presence of an harmonic, in time, external field (frequency bigger than 10^4 Hz) particles are assumed to be at rest, due to inertial reason. In this framework, the response of the cell is due to the H^+ and Cl^- present in the solution. From the spectra of the real and imaginary components of the electric impedance of the cell, by means of a best fit procedure to our model, we derive the effective electric charge of the magnetic particles and the bulk density of ions. From an independent measurement of the ζ -potential of the suspension, it is possible to calculate the hydrodynamic radius of the particle, in good agreement with that independently measured.

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