

# *Acoustic Spectroscopy for Colloids Dispersed in a Polymer Gel System*

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The technique of acoustic spectroscopy offers some significant advantages over conventional techniques, such as dynamic light scattering or differential sedimentation (centrifugation) for the characterization of colloidal dispersions in that it does not require that the systems be highly dilute and transparent. Another advantage of the method may derive from the fact that in application, relative motion between any particle and the medium is very small, at the most being comparable to the particle size. It may thus be suited, within limits, to the study of dispersions in polymer gels, without the additional limitation of conventional methods to transparent media (matching refractive index of polymer and liquid). The present work seeks to probe experimentally the limits of the technique and its current theory for the determination of particle size distributions in gel media. Experiments measuring acoustic attenuation have been conducted on dispersions of silica particles of varying size in aqueous hydroxylpropyl cellulose (HPC) gels of varying cross link density. The particle size distribution (PSD) was successfully measured by acoustic attenuation theory for dispersions in Newtonian media provided that the hydrodynamic particle diameter, was less than the hydrodynamic mesh size of the gel, as given by simple rubber elasticity theory, (mesh size / particle size  $\gtrsim 1.5$ ). The same results were obtained at particle loadings of up to 15 wt%. If the particles are larger than the mesh size, a viscoelastic response from the gel matrix is observed which cannot be interpreted to yield particle size using the existing theoretical framework.

## *Electroacoustics of Particles Dispersed in Polymer Gel*

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This study examines the electroacoustics of particles dispersed in polymer hydrogels, with the particle size either less than or greater than the gel mesh size. When the particles are smaller than the gel mesh size, their acoustic vibration is resisted by only the background water medium, and the measured dynamic electrophoretic mobility,  $\mu_d$  (obtained in terms of colloid vibration current, CVI), is the same as in water. For the case of particles larger than the gel mesh size,  $\mu_d$  is decreased due to trapping, and the net decrease depends on the viscoelastic properties of the gel. The gel mesh size was varied by varying its crosslink density, the latter being characterized as the storage modulus,  $G'$ . The dependence of mobility on  $G'$ , for systems of a given particle size, and on particle size, for gels of a given  $G'$ , are investigated. The measured mobility remains constant as  $G'$  is increased (i.e., mesh size is decreased) up to a value of approximately 300 Pa, beyond which it decreases. In the second set of measurements, the trapped particle size was increased in a gel medium of constant mesh size, with  $G'$  approximately 100 Pa. In this case, the measured  $\mu_d$  is found to be effectively constant over the particle size range studied (14-120 nm), i.e., it is independent of the degree of trapping as expressed by the ratio of the particle size to the mesh size.

## Electrophoretic Mobility of Poly(acrylic acid)-Coated Alumina Particles

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The effect of poly (acrylic acid) (PAA) adsorption on the electrokinetic behavior of alumina dispersions under high pH conditions was investigated as a function of polymer concentration and molecular weight as well as the presence, concentration and ion type of background electrolyte. Systems of this type are relevant to nuclear waste treatment, in which PAA is known to be an effective rheology modifier. The presence of all but the lowest molecular weight PAA studied (1800) led to decreases in dynamic electrophoretic mobility at low polymer concentrations, attributable to bridging flocculation, as verified by measurements of particle size distribution. Bridging effects increased with polymer molecular weight, and decreased with polymer concentration. Increases in background electrolyte concentration enhanced dynamic electrophoretic mobility as the polymer layers were compressed and bridging was reduced. Such enhancements were reduced as the cation was changed from  $K^+$  to  $Na^+$  to  $Cs^+$ .