Using NMR Relaxation to Investigate Adsorption Phenomena

Application Note 122

Environmental pressures are driving the need to produce more sophisticated detergent blends. Nanoparticulate API formulations and drug delivery platforms necessitate elaborate stabilization. Cosmetics and paints increasingly contain mixed suspensions. Optimizing stability of each of these multi-component systems poses significant problems. Polymers are frequently used in conjunction with surfactants in industrial, agricultural, pharmaceutical and foods products. Understanding their adsorption onto the surface of inorganic and organic particles is a key to the preparation of stable dispersions. The importance of the dispersion process and its profound effect on the economics and quality of the subsequent product has long been recognized; the economic impact of incorrect mixing can be considerable.

Any substance that adsorbs from solution onto a particle surface must displace the fluid that already wets the surface and, in so doing, will cause a change in the suspension relaxation time. NMR relaxation measurements can be used to study adsorption and desorption processes and, importantly, competitive adsorption from aqueous, or non-aqueous, media onto surfaces. This is illustrated in the following examples.

Poly(vinylpyrollidone) (PVP) is a water-soluble polymer widely used in cosmetics and pharmaceuticals. Figure 1 is an NMR relaxation measurement showing an initial strong adsorption of a PVP (M_w: 55kD) onto 15nm silica nanoparticles, with a plateau at almost 1mg m^{-2}, resulting in a well sterically-stabilized dispersion. Sodium dodecyl sulfate (SDS) is an anionic surfactant that does not bind to silica but is known to form a complex through sequestration with PVP. Figure 2 shows that, as the SDS concentration increases, the relaxation rate approaches that of the bare silica particles in water, where the dispersion is stabilized only electrostatically. These data demonstrate the striking desorption of PVP from the silica surface upon addition of the SDS and its consequence to the nature of the dispersion. NMR relaxation measurements using the Acorn Area™ offer a new opportunity not only to study adsorption phenomena at interfaces but also to optimize commercially relevant formulations.

Figure 1

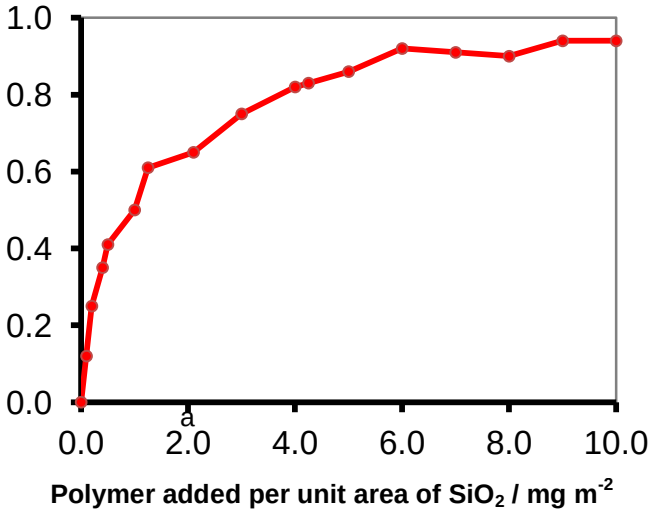
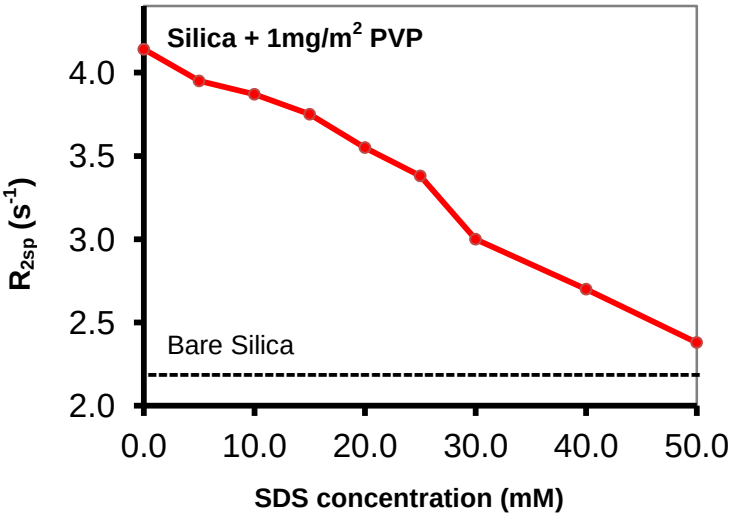


Figure 2



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