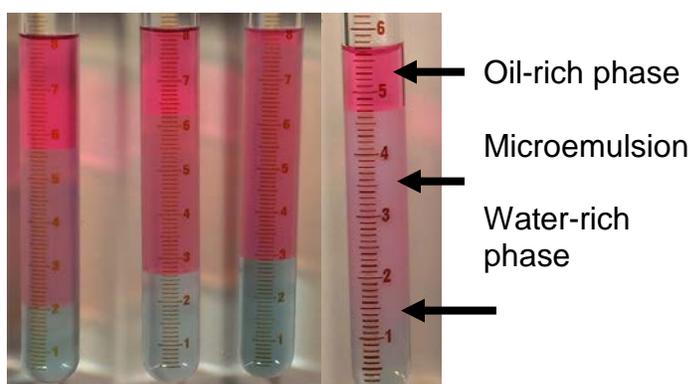# Microemulsion Relaxation

The ease of formation and stability of microemulsions has prompted a rapid increase in their use in major industrial applications. Two important examples are enhanced oil recovery and drug carrier systems for oral, topical and parenteral administration. In the former, microemulsions are the key to efficient extraction of crude oil by dramatically reducing the interfacial tension, i.e., "chemical flooding". In the latter, they offer not only the advantage of ease of manufacturing and scale-up but also improved drug solubilizaton and bioavailability.

Physical analysis of any colloidal ("nano") system is important, but because microemulsions are clear and, since microemulsion domains exist only at fairly narrow concentrations of the three basic components, dilution is almost never an option. Hence, investigation by conventional light-scattering techniques is difficult, if not impossible. X-ray- and neutron-scattering and dielectric measurements have been used to provide insight into the structure and dynamics of microemulsion systems but such measurements are not routine and, certainly, are not suited to normal laboratory analysis.

NMR relaxation measurements are non-invasive and non-destructive. Samples can thus be measured without dilution, stored under thermally controlled conditions (e.g. ICH guidelines) and re-analyzed to understand thermodynamic stability.

The photo below shows four model microemulsion systems created at different oil/water concentrations. The initial water-phase contained an electrolyte, a surfactant and a co-solvent. A dye was used to help distinguish the different domains.

Oil-rich phase

Microemulsion

Water-rich phase

Samples can be extracted from each of the three domains and separately measured.

A double exponential fit to the NMR relaxation data for the microemulsions results in two T_2 relaxation times. Figure 1 shows that the *short* T_2 tracks directly with the % oil in the microemulsion.
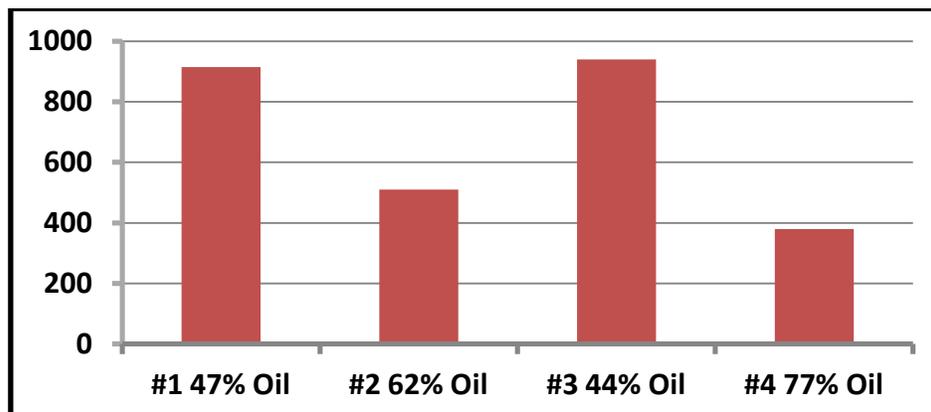
Importantly, NMR relaxation measurements can be made on the initial preparatory water, or oil, phase and then compared with the corresponding phase after creation of the microemulsion. An example is shown in Figure 2 where Sample #6 is an initial aqueous phase and Sample 10 is the subsequent water-rich phase. The presence of surfactant and co-solvent reduces the T_2 relaxation time when compared with simple electrolyte solution. However, it is clear that following emulsification, virtually all of the surfactant and co-solvent has migrated from the initial water phase.
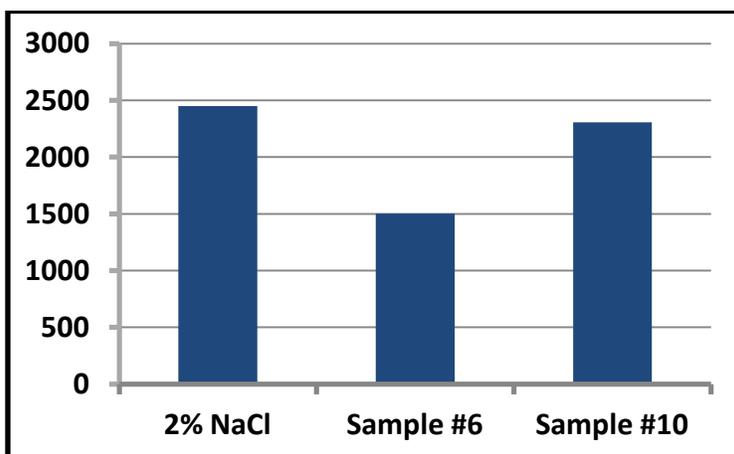
NMR relaxation is thus a useful new tool to easily and routinely study the composition and formulation of micro-emulsion systems.