Catalytic Coating Dispersion Efficiency

Application Note 131

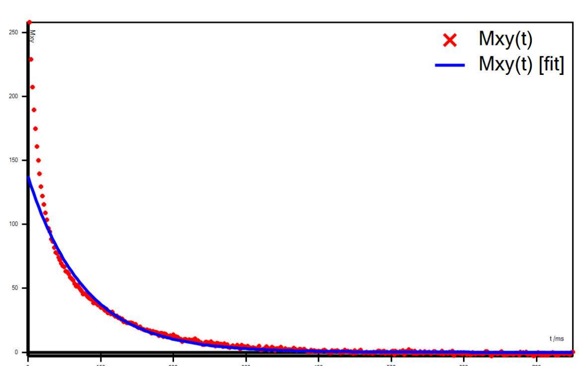
Coating formulations are often used as a catalyst delivery system. The coating is applied to a substrate, and the intention is to have the catalyst particles uniformly distributed throughout the coating formulation so that the exposed catalyst surface is maximized. Challenges arise because concentrated nanoparticle systems may exhibit complex material behavior such as aggregation which can affect catalyst efficiency.

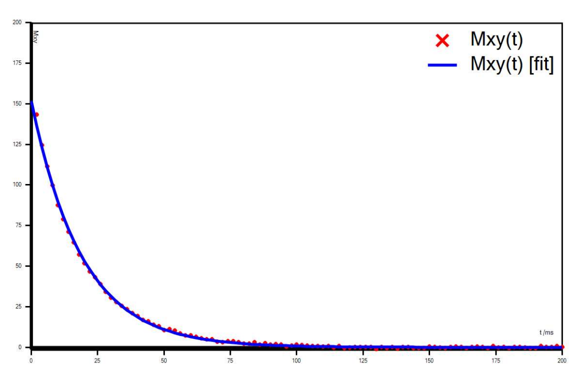
Time domain magnetic resonance measurements provide unique insight into the structure of particles in complex liquids. One of the biggest advantages of this approach is that coating formulations can be studied in their native state, without dilution. In contrast, light based particle size analysis requires extreme dilution of the formulation, providing little information about the particulate macrostructure of the concentrated coating formulation. Magnetic resonance results are uniquely sensitive to the smallest particles in a concentrated formulation because the smallest particles contribute most to the total surface area of the dispersion.

A non-porous particulate dispersion of non-interacting particles should produce a single relaxation time in response to an RF pulse sequence which can be related to the wetted surface area by appropriate consideration of the particle concentration. These formulations would also exhibit netwonian behavior in a flow curve. When particles aggregate, liquid domains may exist which produce multiple relaxation times. The intensity of the shorter relaxation times indicates the quantity of fluid trapped inside the particle aggregates. Monitoring the intensity of these times and their dependence on shear provides the user with a mechanism to study the dynamics of structure formation of the catalyst formulation.

The figures below compare a well dispersed catalyst formulation (right) with a catalyst formulation showing significant macro structure (left). In each figure, the red x indicates the experimental data, the blue line represents a single relaxation time fit. Data from the well dispersed formulation at right is well described by a single relaxation time, while the data at left shows a systematic deviation to the single relaxation time fit at short times due to the macrostructure formed by the catalyst particles in the dispersion. The Y intercept of the experimental data indicates the quantity of liquid trapped in the aggregates of the dispersion.

The strategy to eliminate aggregation lies in the formulation of the dispersion. For example, polymeric stabilizers can form macrostrucures via hydrogen bonding, polymer bridging, etc. Combining a flow cell with a magnetic resonance device provides even more insight about the interaction between shear, structure formation, and formulation chemistry.





(844) 367-9446 fax: (800) 428-9049 www.xigonanotools.com