Improving Magnetic Dispersions by Applying DC Magnetic Fields

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Objectives

• To investigate the behavior of magnetic dispersions before and after applying a DC magnetic field
  – Rheological characteristics
  – Magnetic characteristics

• Investigate the break-up of “doublets”
Magnetic Susceptometer
Magnetic Dispersion: Doublets

- Two particles aligned antiparallel to each other
Theory of Doublet Break-up

- Particles bound antiparallel to each other
- Transverse DC field aligns particles and switches their magnetic moment
- Particles move apart and surfactant absorbs onto new surface
DC On/Off Experiment

Magnetic Susceptibility (a.u.) vs. Time (seconds)

DC field on

DC field off

Time (seconds)

0 10 20 30 40 50 60 70

0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4

100 G ▲ 400 G
1200 G ▲ 800 G
1400 G ▲ 1800 G
1600 G ▲ 2200 G
1800 G ▲ 2600 G

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Percent Increase in Magnetic Susceptibility

Percent Increase in $\chi^1$

DC Field (Gauss)
Switching Field Distribution

![Graph showing the switching field distribution with applied field (Oe) on the x-axis and dM/dH on the y-axis. The graph displays a distribution of data points indicating the switching behavior at different applied field values.]
Percent Increase in Storage Modulus

![Graph showing the percent increase in storage modulus as a function of DC field (Gauss). The x-axis represents the DC field in Gauss, ranging from 0 to 2500, and the y-axis represents the percent increase in storage modulus, ranging from 0% to 25%. The data points indicate a linear trend with an increasing percent increase as the DC field increases.]
Magnetic Susceptibility of a Doublet

• Magnetic field created by one particle interacts with the moment of the other particle.
• The field “pins” the moment.
• Net decrease in magnetic susceptibility
Magnetic Susceptibility of a Doublet

- Split doublets will increase the magnetic susceptibility
Conclusions

• DC magnetic fields can be used to better disperse magnetic particles.

• Breaking the doublets increases:
  – Magnetic susceptibility
  – Storage modulus (elasticity)