UNIVERSITY OF CRETE

DEPARTMENT OF MATERIALS SCIENCE & TECHNOLOGY

GRADUATE SHORT COURSE

COLLOIDAL DISPERSION RHEOLOGY

Professor Jan Mewis

Katholic University Leuven, Belgium

18,19,22,23,24 November 2010

FORTH main building Seminar Room 1 (above main entrance – first floor)

Classes start 10:00 am. Each day about 4 hours with break.

1) Introduction, rheolgical and colloid concepts
2) Hydrodynamic effects/Non-colloidal suspensions
3) Brownian hard spheres
4) Colloidally stable dispersions
5) Nonspherical particles
6) Flocculated systems
7) Rheological measurements of dispersions
8) Viscoelastic media (filled polymers, nanocomposites)
9) Special techniques applicable to dispersions

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(Crete, 18,19,22,23 November 2010)

1) Introduction
   Rheological concepts
   Colloid concepts (if required)
   Some rheological phenomena of colloidal systems
2) Hydrodynamic effects/Non-colloidal suspensions
   Motion of/around particles
   Viscosity of dilute systems (scaling, Einstein, Batchelor)
   Viscosity of concentrated systems (maximum packing, particle size distribution)
   Particle migration
3) Brownian hard spheres
   Structure
   Brownian motion and flow, dimensional analysis
   Universal viscosity curves, scaling principles, the maximum packing problem
   Dynamic moduli, meaning of high frequency moduli, relaxation phenomena
4) Colloidally stable dispersions
   Effects of electrostatic repulsion, screening length, hard sphere scaling, "softness" of interparticle interactions
   Steric repulsion, differences with electrostatic repulsion, effective hard sphere radii, relation between moduli and interparticle potential
5) Nonspherical particles
   Motion during flow, structure
   Viscosity effects of aspect ratio, shear and extensional flow, in dilute and concentrated suspensions
   Colloidal nonspherical particles (rods and plates)
6) Flocculated systems
   Description of the microstructure (fractals, percolation, gelation, glasses)
   Link between structure and rheology (viscosity curves, yield stress, moduli)
   Gels and glasses
   Time effects (ageing, thixotropy)
7) Rheological measurements of dispersions
   Specific problems when measuring dispersions (particle size effects, wall slip, nonlinearities, etc.)
   Measurement procedures for yield stress and thixotropy
8) Viscoelastic media (filled polymers, nanocomposites)
   Flow phenomena (drag force, migration, chaining)
   Viscosity curves (use of effective shear rate), normal forces

Effect on dynamic moduli (relative moduli)
Extensional flow (effect of particles on extensional viscosity and strain hardening)
Steric stabilization in polymer melts
Special phenomena in nanocomposites
(Optional)

9) Special techniques applicable to dispersions
Large amplitude oscillations
Superposition flows
Microrheology