

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Soft Matter	1
1.2	Colloids	2
1.3	Colloids: Why are Physicists Concerned?	3
1.4	Interactions in Colloidal System	4
1.4.1	van der Waals Forces	4
1.4.2	Double Layer Interactions (Repulsive Potential)	5
1.4.3	Interaction Energy Between Clay Particles	6
1.5	Clays as Colloidal Systems	8
1.6	Description of Nanoclays	8
1.6.1	Laponite	8
1.6.2	Montmorillonite	10
1.7	Objective and Scope of Thesis	11
1.8	Aging and Dynamic Arrest in Colloidal Systems	11
1.9	Definition of Various Non-ergodic States	13
1.9.1	Colloidal Gel	13
1.9.2	Colloidal Glass	13
1.9.3	Comparison Between Gel and Glass	13
1.10	Structure of the Thesis	14
	References	14
<b>2</b>	<b>Materials and Characterization Techniques</b>	<b>17</b>
2.1	Materials Used	17
2.1.1	Nanoclays	17
2.1.2	Solvents	17
2.2	Characterization Techniques	18
2.2.1	Laser Light Scattering	18
2.2.2	Rheology	22
2.2.3	Viscometry	27
2.2.4	Tensiometry	27
2.2.5	Electrophoresis	29
2.2.6	Raman Spectroscopy	32

2.2.7	Transmission Electron Microscopy . . . . .	33
2.2.8	X-Ray Diffraction. . . . .	34
	References . . . . .	36
<b>3</b>	<b>Phase Diagram of Aging Laponite Dispersions . . . . .</b>	<b>37</b>
3.1	Introduction . . . . .	37
3.2	Sample Preparation. . . . .	38
3.3	Results and Discussion. . . . .	38
3.3.1	Hydration of Laponite . . . . .	38
3.3.2	Growth of Structures . . . . .	42
3.3.3	Viscoelastic Behaviour. . . . .	43
3.3.4	Dispersion Homogeneity at $t_w = 0$ . . . . .	46
3.3.5	Phase Diagram . . . . .	48
3.4	Conclusion . . . . .	49
	References . . . . .	50
<b>4</b>	<b>Anisotropic Ordering in Nanoclay Dispersions Induced by Water–Air Interface. . . . .</b>	<b>53</b>
4.1	Introduction . . . . .	53
4.2	Experimental Geometry . . . . .	54
4.3	Experimental Results . . . . .	56
4.3.1	Anisotropic Ordering at the Water–Air Interface. . . . .	56
4.3.2	Effect of Water–Hydrophobic Liquid Interface . . . . .	58
4.3.3	Effect of Temperature. . . . .	58
4.3.4	Relaxation Dynamics . . . . .	59
4.4	Discussion . . . . .	62
4.5	Conclusion . . . . .	63
	References . . . . .	64
<b>5</b>	<b>Phase Diagram of Aging Montmorillonite Dispersions . . . . .</b>	<b>67</b>
5.1	Introduction . . . . .	67
5.2	Sample Preparation. . . . .	68
5.3	Results and Discussion. . . . .	69
5.3.1	Time-Dependent Viscosity . . . . .	69
5.3.2	Visco-Elasticity . . . . .	70
5.3.3	Steady State Viscosity and Yield Stress . . . . .	70
5.3.4	Cole–Cole Plots . . . . .	75
5.3.5	Light Scattering Experiments. . . . .	76
5.3.6	Observation of Phase Separation and Equilibrium Gels and Phase Diagram. . . . .	78
5.3.7	Gelation Kinetics in Percolation Formalism . . . . .	79
5.4	Conclusions . . . . .	80
	References . . . . .	81

<b>6 Sol State Behavior and Gelation Kinetics in Mixed Nanoclay Dispersions</b>	83
6.1 Introduction	83
6.2 Sample Preparation	84
6.3 Result and Discussion	85
6.3.1 Sol State Behavior	85
6.3.2 Gel State Properties of Mixed Clay Dispersions	87
6.3.3 Visco-Elastic Properties	89
6.3.4 Gelation Kinetics in Percolation Formalism	94
6.4 Conclusion	99
References	100
<b>7 Aging Dynamics in Mixed Nanoclay Dispersions</b>	103
7.1 Introduction	103
7.2 Sample Preparation	104
7.3 Results and Discussion	104
7.3.1 Concentration Dependence	104
7.3.2 Ergodicity Breaking Time	105
7.3.3 Relaxation Dynamics	107
7.3.4 Behavior of the System $\phi < \phi_{cutoff}$	111
7.3.5 Growth of Anisotropy with Aging	111
7.3.6 Cole–Cole Plot and Sample Heterogeneity	113
7.4 Dilution Experiment	115
7.5 Conclusion	115
References	116
<b>8 Thermal Ordering in Mixed Nanoclay Dispersions</b>	119
8.1 Introduction	119
8.2 Results and Discussion	119
8.3 Application of Landau Theory	124
8.4 Conclusion	127
References	128
<b>9 Aggregation and Scaling Behavior of Nanoclays in Alcohol Solutions</b>	131
9.1 Introduction	131
9.2 Sample Preparation	132
9.3 Results and Discussion	133
9.4 Conclusion	138
References	138
<b>10 Summary</b>	141
10.1 Summary of the Main Results	141
10.2 Open Problems	144

**Appendix . . . . . 147**

**Curriculum Vitae . . . . . 151**

Dispersion Stability, Microstructure and Phase  
Transition of Anisotropic Nanodiscs

Pujala, R.K.

2014, XVI, 154 p. 95 illus., 26 illus. in color., Hardcover

ISBN: 978-3-319-04554-2