Research on the Microstructure and Properties of Compound Modification of Stearic acid-Gly -Ti-O Particles ER Fluid

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***Abstract*—This paper emphasis has researched the Microstructure and Properties of compound modification of stearic acid-Gly -Ti-O particles ER fluid, It is found that Stearic acid-Gly -Ti-O modification has major effect on shear stress and chain of particles.**

Keywords-Stearic acid-Gly -Ti-O Particles, ER fluid

Ti-O group electrorheological fluid is a new ER fluid, they have also high shear stress, good sedimentation ratio and making simple and etc, except when electric field was exerted, the viscosity, shear stress strength and etc of electrorheological fluid can change instantaneously, when electric field was removed, it also can be back to liquid in milliseconds time, a reversible control mechanical behavior makes it have wide application good in damper field and etc [1,2,3]. But the property of pure Ti-O group electrorheological fluid is low, sedimentation ratio is poor, It has proved that polar molecule can greatly increase ER properties, and alter microstructure. Especially for electric conduction particles, it must be surround by dielectric materials making compound. For Ti-O particles, it modified with / stearic acid and glycerine, formed Ti-O/stearic acid -glycerine particles. This paper focuses on the research of properties and microstructure of Ti-O/ Stearic acid -glycerine particles electrorheological fluid under different electric field, grasp the low of Ti-O/ stearic acid -glycerine particles electrorheological fluid.

I. EXPERIMENTAL PROCEDURE

Using **precipitation method** preparation acid-glycerine modification Ti-O particles, washing the particle time and again, dislodging impurity of particle surface, heating the particle 16h under 60℃ water, grinding the particle and pretreatment, particle surface activation treatment and hydroxyl, under 60℃cheatment 2h, adding Ti-O/acid-glycerine particles to dry and methyl silicone oil in 60wt%, then different particles electrorheological fluids were made, Gly-Ti-O is mark S0, different acid content are mark A1,A2,A3 and A4, Tab. 1 is amount of Stearic Acid. The electrorheological fluid of shear strength, leakage current density, etc were measured by MCR301 revolving viscometer. The structure micrographs of particles were observed by high resolution electron microscopy, FT-IR spectra were test by NEXUS EURO infrared spectrometer. In Tecnai G220 S-Twin type high resolution were observed under TEM particles morphology and energy score, XRD patterns is obtain by XRD-6000 X,etc.

TABLE I. AMOUNT OF STEARIC ACID (WT.%)

S0	A1	A2	A3	A4
0	1%	2%	5%	10%

Sedimentation is measured as Fig. 1,

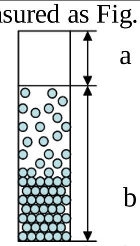

Figure 1. Sedimentation model of ER fluid

II. RESULTS AND ANALYSIS

Fig. 2 shows molecular structure formula of stearic acid and Gly,

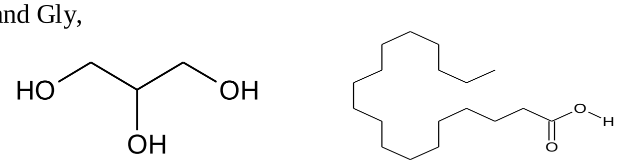

Figure 2. Molecular structure formula of Stearic Acid and Gly

Fig. 3 shows XRD patterns of pure Gly-TiO particles and stearic acid-Gly-TiO particles, through XRD morphology of Gly-O-Ti particles, you can see that diffraction patterns are similar, dispersion peak is at 65^{o} ,there is nor crystal diffraction peak, it is said particles is amorphism.

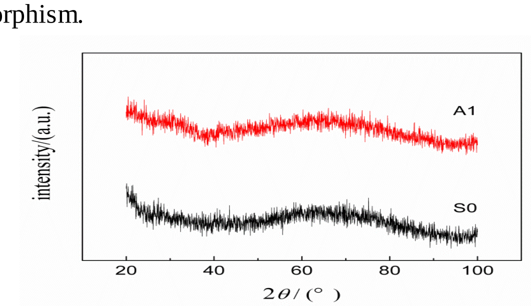

Figure 3. XRD patterns of pure Gly-TiO particles and Stearic Acid-Gly-TiO particles

Fig. 4 is the FT-IR spectra of the stearic acid-Gly-TiO particles and Gly-TiO particles, in FT-IR morp peak at morphology, for Gly-TiO particles, there are peak at 3400cm^{-1} , comparison with stearic acid-Gly-TiO particles, characteristic wave of glycerol is deviation to left side,

Ti-O characteristic wave of 500~800cm^{-1} is become narrow. Peak intensity of stearic acid-Gly-TiO particles at 800~1200cm^{-1} is increase, it is said that reaction of stearic acid and Gly-TiO have take place.

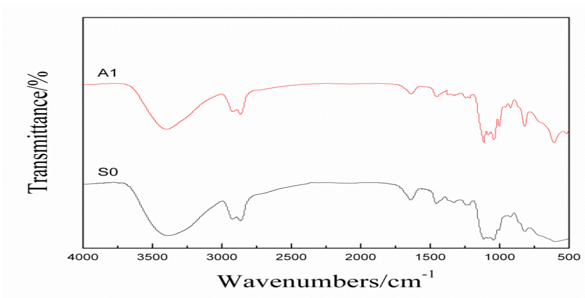

Figure 4. FT-IR spectra of Gly-TiO particles and Stearic Acid-Gly-TiO particles

Fig. 5 shows cruve of the shear stress of stearic acid-Gly-TiO particles-based ER fluids against Stearic Acid dosage under different DC fields, you can see from the graph, for Gly-O-Ti particles ERF, there is a best value of stearic acid content, at first, with the increased electric field strength, shear stress of ER increases, when stearic acid content is 2.0, the shear stress of stearic acid-Gly-TiO particles-based ER fluids get biggest value, and than, with the increased electric field strength, shear stress of ER decreases.

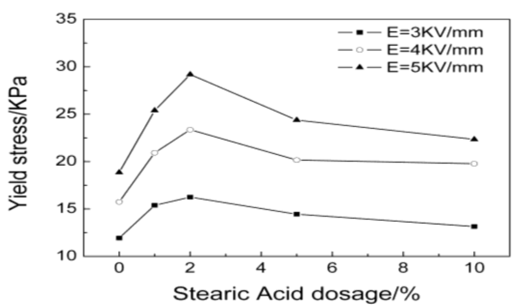

Figure 5. Cruve of the shear stress of Stearic Acid-Gly-TiO particles-based ER fluids against Stearic Acid dosage under different DC fields

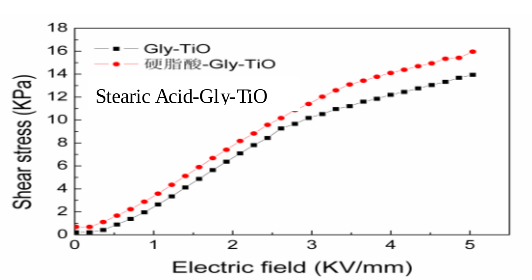

Figure 6. curve of the shear stress of modified ER fluids against different DC fields under shear rate 1s^{-1}, you can see from the graph, for Stearic Acid-Gly-TiO and Gly-O-Ti particles ERF, with the increased electric field strength, shear stress of ER increases,but shear stress of Stearic Acid-Gly-TiO ERF is higher than Gly-O-Ti particles ERF

Fig. 6 shows curve of the shear stress of modified ER fluids against different DC fields under shear rate 1s^{-1},

Fig. 7 shows cruve of the Current density of the Stearic acid modified ER fluid against stearic acid dosage with weight fraction 60% under DC electric fields, you can see from the graph, for Stearic Acid-Gly-TiO particles ERF, with the increased stearic acid dosage, Current density of ER increases rapidly.

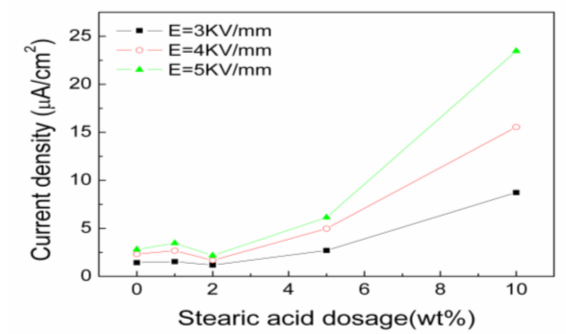

Figure 7. Cruve of the Current density of the Stearic acid modified ER fluid against stearic acid dosage with weight fraction 60% under DC electric fields

Fig. 8 shows sendimentation of Stearic Acid modified particales(10 wt.%_, you can see from the graph, for Stearic Acid-Gly-TiO particles ERF, with time increased , sendimentation of ER decreases rapidly at first, and than, sendimentation of Stearic Acid modified particales is steady. for example, when Stearic Acid content is 1%, Sedimentation ratio is 54% after 24h, when Stearic Acid content is 2%, Sedimentation ratio is 50% after 24h, and than , with Stearic Acid content increased , sendimentation of ER decreases rapidly.

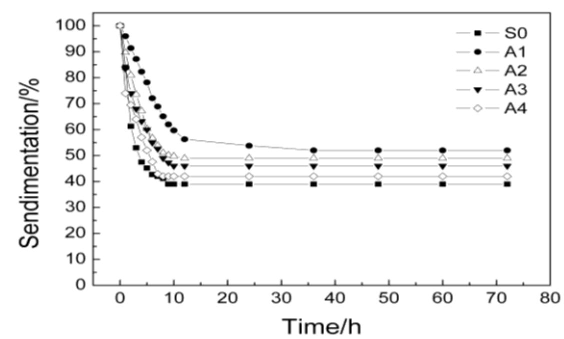

Figure 8. Sendimentation of Stearic Acid modified Particales(10 wt.%)

Fig. 9 shows microstructure photograph of Stearic Acid modified Gly-TiO particles-based ER fluids at 2kVmm^{-1}, As can be seen from the micrograph, at first, the number of column of the electrorheological particles is increase with stearic acid content increase, the column of electrorheological particles become thickset, but when stearic acid content is over 2%, the number of column of the electrorheological particles is decrease with stearic acid content increase, the column of electrorheological particles become scarce. The result is same as property law.

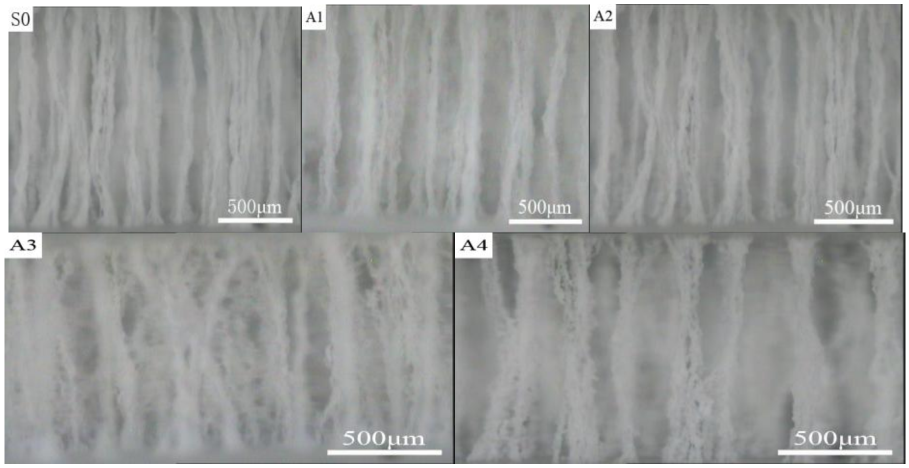

Figure 9. Microstructure photograph of Stearic Acid modified Gly-TiO particles-based ER fluids at $2kVmm^{-1}$.

III. CONCLUSIONS

1) for Stearic Acid-Gly-TiO and Gly-O-Ti particles ERF, with the increased electric field strength, shear stress of ER increases,but shear stress of Stearic Acid-Gly-TiO ERF is higher than Gly-O-Ti particles ERF. when stearic acid content is 2.0, the shear stress of stearic acid-Gly-TiO particles-based ER fluids get biggest value, and than, with the increased electric field strength, shear stress of ER decreases.

2) for Stearic Acid-Gly-TiO particles ERF, with time increased , sendimentation of ER decreases rapidly at first, and than, sendimentation of Stearic Acid modified particales is steady. For same condition, images of columns is different, shear stress is large, the size of column is thicker.

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