Preparation of Microencapsulated Electrophoretic Ink used for an Electronic Paper

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Abstract

An electrophoretic display (EPID) based on the movement of particles in an insulating liquid is well known to be one of the technology utilized for the electric paper and has been actively investigated in the past few years. Micro-encapsulation of non-aqueous dispersion containing with white and black particles is reported in this paper. The melamine resin was used for wall material of micro-capsule. The optimization of the preparation condition of the micro-encapsulation was done. The EPID using the micro-encapsulated electrophoretic ink displays black and white solid image in the response to an external voltage.

Introduction

An electrophoretic display (EPID) is reflection type image display based on the movement of particles in an insulating liquid. The application of EPID for the electron paper is expected because the EPID exhibits paper-like readability, wide viewing angle, long memory, high image contrast and low power consumption. The long standing problems will be solved by using micro-encapsulation technology.[1] In this paper, preparation of microencapsulated electrophoretic ink used for an electronic paper is reported.

Electrophoretic Display

Figure 1 shows the schematic cross section of image display cell using micro-encapsulated electrophoretic ink. The both of electronic charged black and white particles are suspended in the insulating liquid. The positive charged black particles move to the top of capsule by application of external negative voltage and the black image can be seen through the top transparent electrode. In the meantime, the negative charged white particles move to the bottom of capsule. The black and white image can be displayed by the change of polarity of applied voltage.

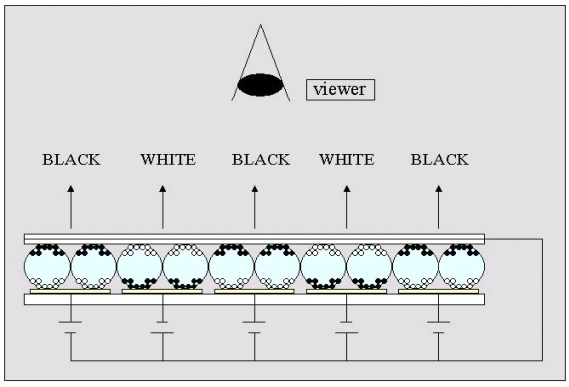

Figure 1. Schematic cross section of micro-encapsulated electrophoretic display.

Experimental

Micro-Encapsulation Steps

The micro-encapsulated electrophoretic ink was synthesized by in-situ polymerization. Figure 2 shows the preparation steps of micro-encapsulation using melamine polymer as the wall material of capsule. By in-situ polymerization, the monomer is supplied from the water phase and polymerized at the interface in water and oil. The microcapsules of oil are obtained.

Results and Discussion

Emulsion

The size distribution and stabilization of an emulsion as the core material in the water phase effects on the size and stabilization of the microcapsule under the preparation of micro-encapsulation. The uniform emulsion makes uniform capsule in this preparation process. The effects of the kind of surfactant, pH and stirring speed on the size and stabilization of capsule were investigated. The 5wt% stylene-maleic acid co-polymer and aliphatic hydrocarbons were used for surfactant and dispersed phase, respectively. Figure 3 shows the relation between pH and average emulsion particle diameter as the function of stirring speed. The emulsion is stabilized at pH4 and emulsions with a large size are formed.

The effect of surfactant on the preparation of capsule was investigated. The isobutylene-maleic acid co-poymer (pIMA), stylene-maleic acid co-polymer (pSMA) and the sodium-dodecyl-sulfate (SDS) were used as surfactant. The oil was en-capsulated only using pIMA which is a weak surfactant. Figure 4 shows the optical micrograph of microcapsule containing the oil using pIMA surfactant. The strong surfactant is not desirable for the preparation of micro-capsule in this case.

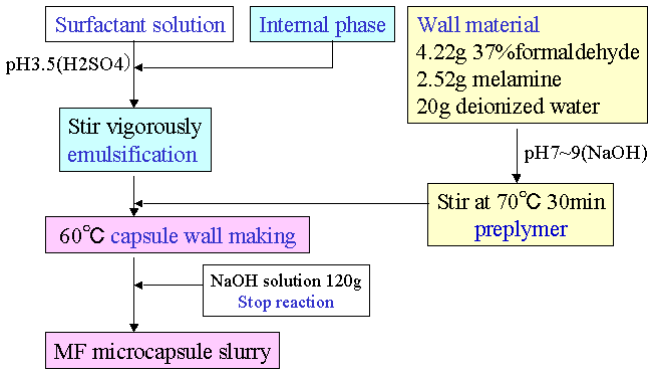

Figure 2. Preparation of melamine microcapsule by in situ polymerization

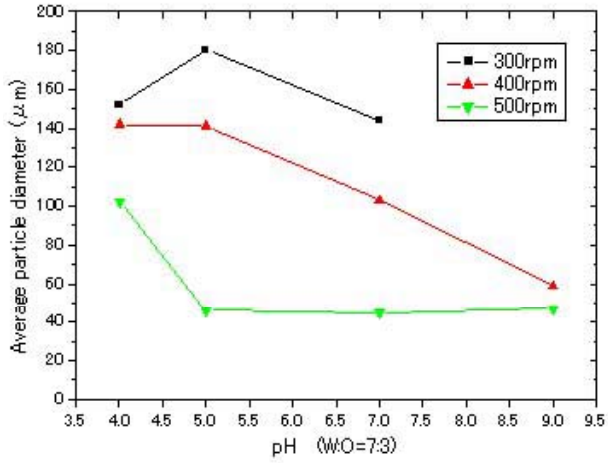

Figure 3. Relation between emulsion particle diameter and pH in solution as the funcgiton of stirring speed.

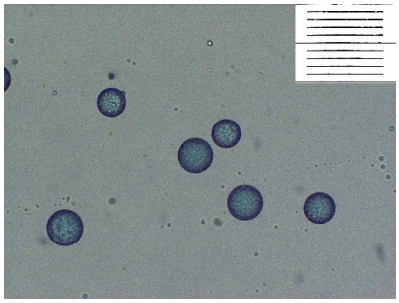

Figure 4. Optical microphotograph of microcapsule containing oil using isobutylene-maleic acid co-poymer as surfactant.

The Encapsulation of the Particle and Surfactant in Dispersed Phase

The titanium dioxide, TiO_2 and carbon black particles covered with a functional polymer were used for electrophoretic white and black particles, respectively. The micro-capsules containing TiO_2, carbon black particles and insulating liquid were obtained.

The addition of surfactant to oil phase effects on the en-capsulation. Figure 5 shows the size distribution of micro-capsule containing oil, particles and surfactant. The size distribution of microcapsule was changed by the including of particles because the particles adhere to the capsule wall. By the addition of surfactant, the size distribution curve of capsule containing oil and particles is same as the capsule with oil. It is considered that the particles do not adhere to the capsule wall by adsorption of surfactant to the surface of particle and interface between water and oil phase.

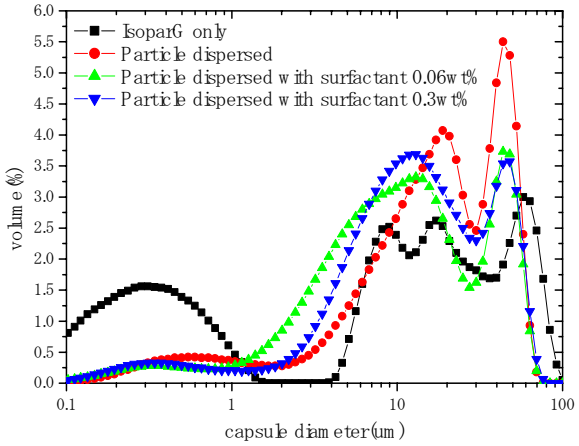

Figure 5. Size distribution of micro-capsule

EPID Characteristics

Microcapsules containing black and white particles were prepared and coated onto a transparent electrode. This EPID shows black and white states by application of external voltage. The optical reflectances in black and white solid area are 1.15 and 0.85, respectively.

Conclusion

Micro-encapsulation of dispersion containing with white and black particles dispersed in an insulating liquid is reported. The melamine resin was used for wall material of micro-capsule. The optimization of the preparation condition of the micro-encapsulation was done. The EPID using the micro-encapsulated electrophoretic ink displays black and white solid image in the response to an external voltage.

References

1. B. Comiskey, J. D. Albert. H. Yoshizawa and J. Jacobson, Nature, vol. 394, pp. 253-255 (1998)

Author Biography

Tutomu Shimano received the B.S. degree in information engineering from Chiba University in 2004. I am a student in Graduate School of Science and Technology, Chiba University since.