The Novel Preparation of White Pigment by Functionalized Wax Coating of TiO_2 for Electrophoretic Display

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Abstract

In this study, we have investigated a simple process of preparation of white pigment particles by physical coating with functionalized wax for the electrophoretic display. We will discuss, especially, the implementation of bistable pigment providing high mobility by using unique charge control agent and also optical properties of wax coated TiO_2 particles.

1. Introduction

Lightweight, flexible reflective paper-like displays are of great interest for applications in portable displays and advertisement, such as PDAs, electronic newspapers, and e-books as well as out- and in-door advertisement. The reflective paper-like displays involve a microcapsule-type electrophoretic display[1-3], a twisting ball display[4], an in-plane type electrophoretic display[5], and a cholesetric liquid crystal display[6].

Among them, microcapsule-type electrophoretic display, which showing image and text using moving charged particles by applied voltage, might be one of the most promising candidate because it offers novel advantages such as ink-on-paper appearance, high reflectance, good contrast ratio, wide-viewing angle, image stability in the off state, and extremely low power consumption.

The microcapsule-type electrophoretic display consists of millions of tiny microcapsules, each one containing charged white pigment particles that react to an external electric field to form an image. This particles are dispersed in a suspending fluid and then would be encapsulated into microcapsules by in-situ polymerization or coacervation process microcapsules with diameters in a range of 50-200 μm.

The structure of a microcapsule-type electrophoretic display is illustrated in Figure 1. In the single particle in dye system, optical contrast is achieved by moving pigment particles in a black dyed medium. The pigment backscatters light when it is bought near the viewer, and the dye absorbs light when the pigment is drawn away form the viewer.

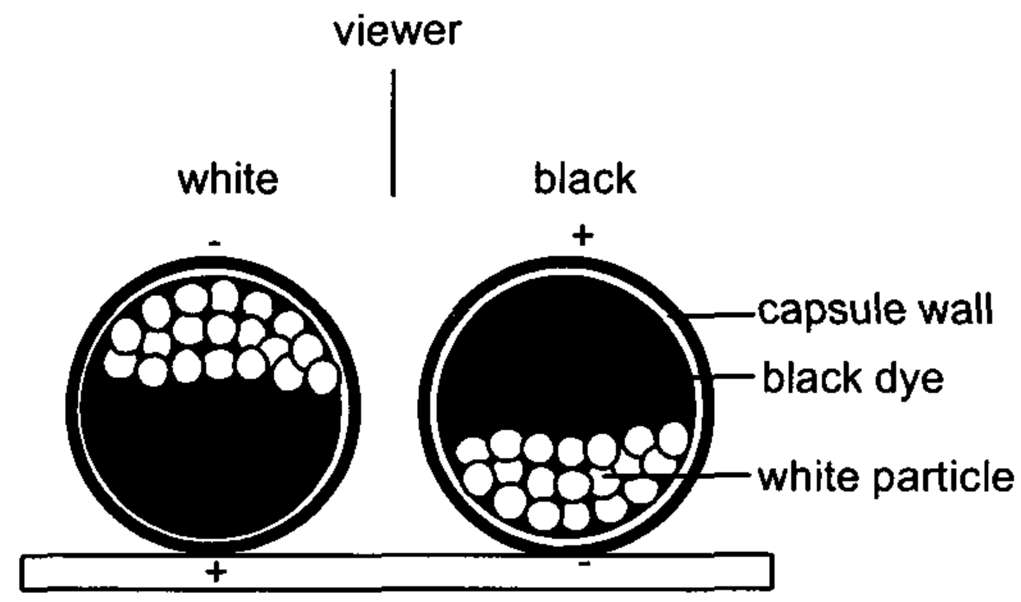

Figure. 1 Schematic illustration of microcapsule-type electrophoretic display.

The degree of bistability can be controlled through appropriate chemical modification of the electrophoretic particle.

In order to realize a printable bistable display system, it's necessary to coat white particle with functionalized polymer for matching the density of the particles to that of the surrounding medium. This polymer coating also can prevent the agglomeration of the particles and surface charge of the pigment can be easily controlled by attaching the charge control agent to the functional group of polymer[7].

In this study, we have investigated a simple process of preparation of white pigment particles by physical coating with functionalized wax for the electrophoretic display.

2. Results and Discussion

The white pigment was fabricated by combining a homogeneously dispersed TiO_2 particles with commercially available functionalized wax with stirring at high temperature greater than T_m of the wax. By allowing the reaction mixture to cool, the dissolved polymer absorbed onto the surface of the TiO_2 particle, finally it was crystallized and precipitated to form spherically coated particles. The solvent can be aqueous, non-volatile hydrophobic solvent (suspending fluids) or protic volatile solvent (alcohols). The dispersion condition of TiO_2 particles was very related to the dielectric matching between solvent and TiO_2 particles. After removing the solvent by centrifuging then freeze drying, the resulting particles were sieved to obtain small dried powder. The coating thickness can be easily controlled compared to polymerization method. The grafted functional group of wax serves reactive sites for surface charging by coordination or binding to charge control agent.

Figure 2 shows a SEM micrograph of the spherically wax coated TiO_2 particle mixtures before sieving; the particle size was distributed in the range of 0.5 μm ~ 15? μm. To be encapsulated and density matched in suspending fluid, the mean diameter of particle should be in the range of 0.5 μm ~ 2 μm by sieving or monodispersed reaction condition.

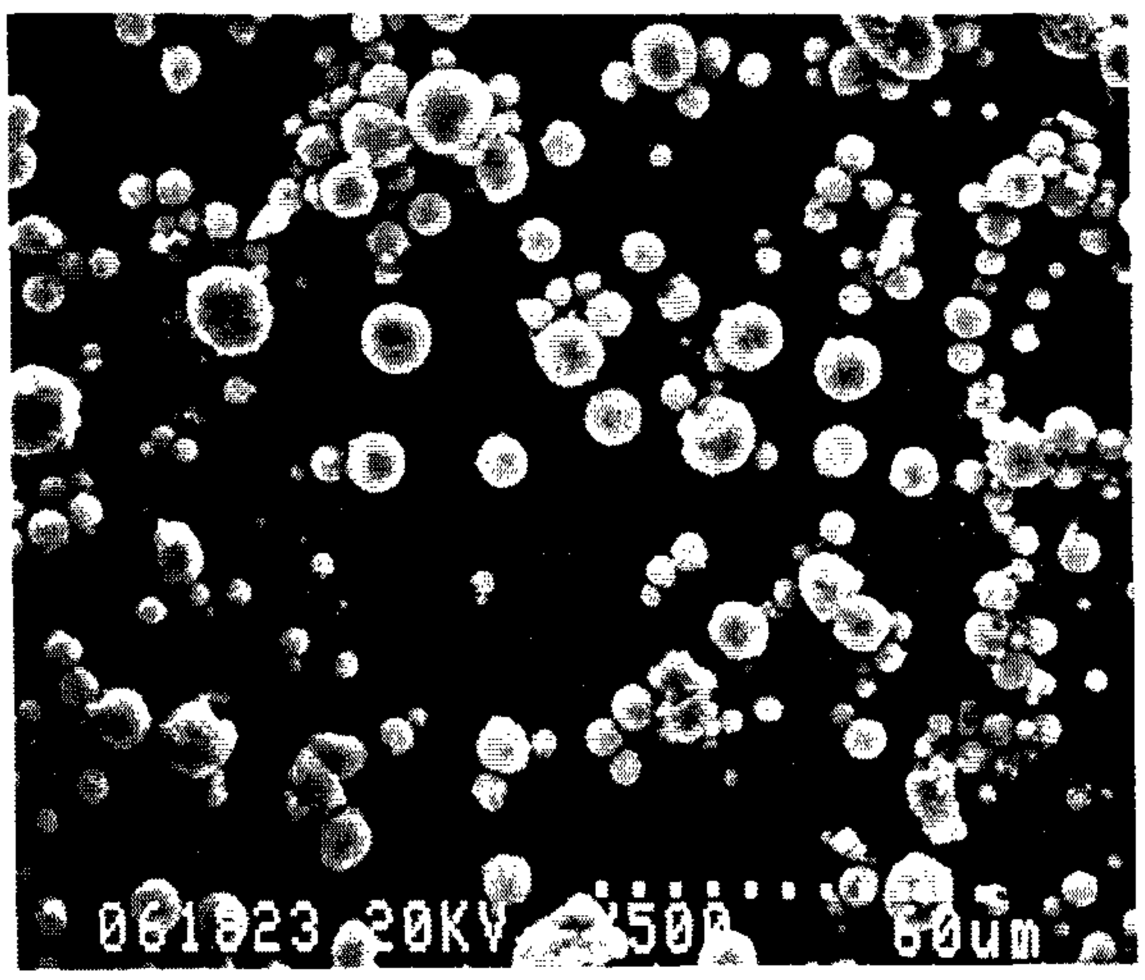

Figure 2. Scanning electron microscopy photograph of wax coated TiO_2 particles.

Figure 3 indicates the Fourier Transform Infrared Spectroscopy (FTIR) spectra of the wax coated particles, the characteristic peak of Ti-O stretching band was observed around at 686 cm^{-1}, and the other peaks (C-H stretching band at 2915 cm^{-1} and C=O stretching band at 1708 cm^{-1}) were from the coated wax.

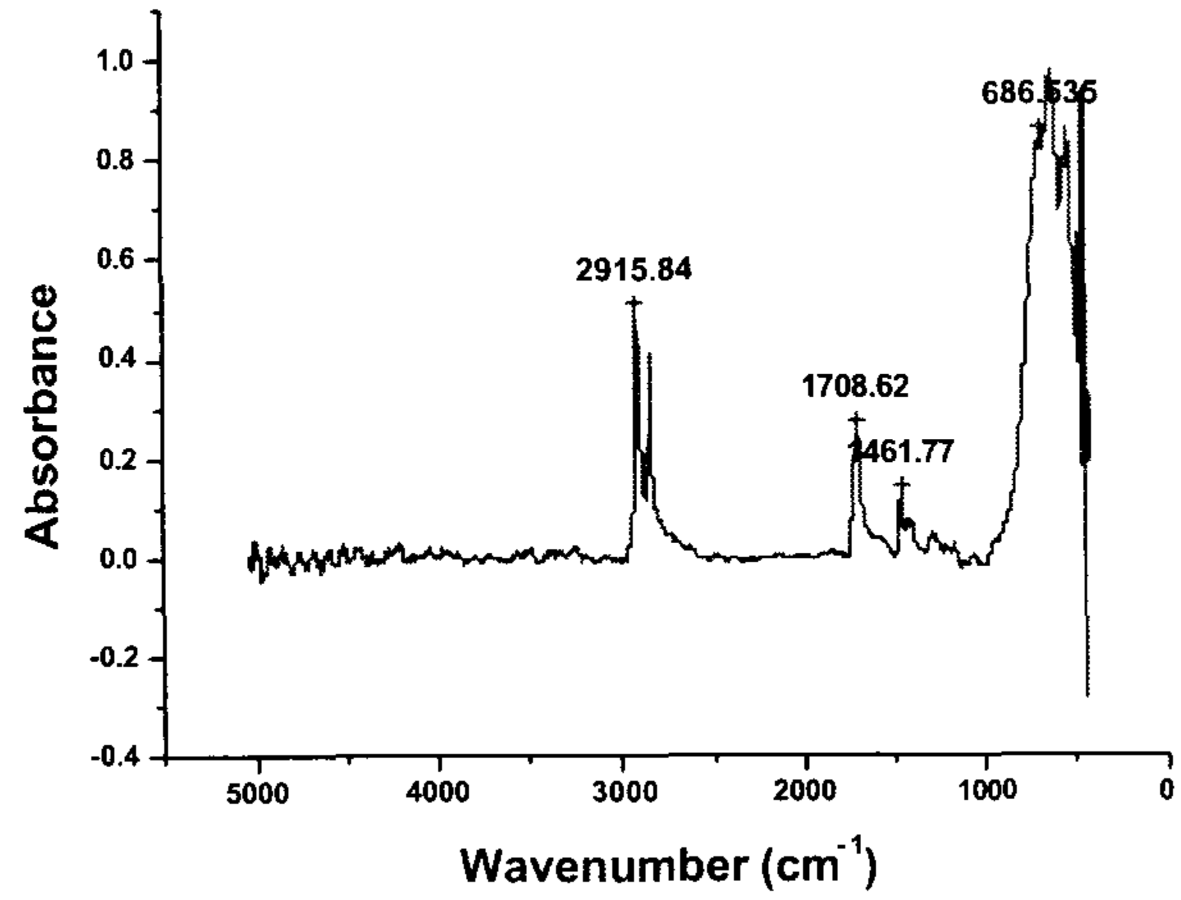

Figure 3. FTIR spectrum of wax coated TiO_2 particles.

The amount of coated wax and thickness could be estimated by thermogravimetric analysis (TGA) as shown in Figure 4. The TGA graph of used wax indicated that its decomposition was completed at about 470 °C and bare TiO_2 was almost stable up to 600 °C. Therefore the mean weight percent of coated wax could be calculated to 35% and 55% for remained TiO_2 among the wax coated TiO_2 particles.

These dried microparticles were then redispersed in a suspending fluid to react with diverse charge control agents (CCA) serving steric stabilizer to minimize coagulation. Electrophoretic mobility measurements were made by electrophoretic light scattering using a Zetasizer (Malvern, U.K.) as shown in Table 1.

We measured the surface charges (zeta potential) and mobilities of bare TiO_2, wax coated pigment and CCA attached particle, repectively.

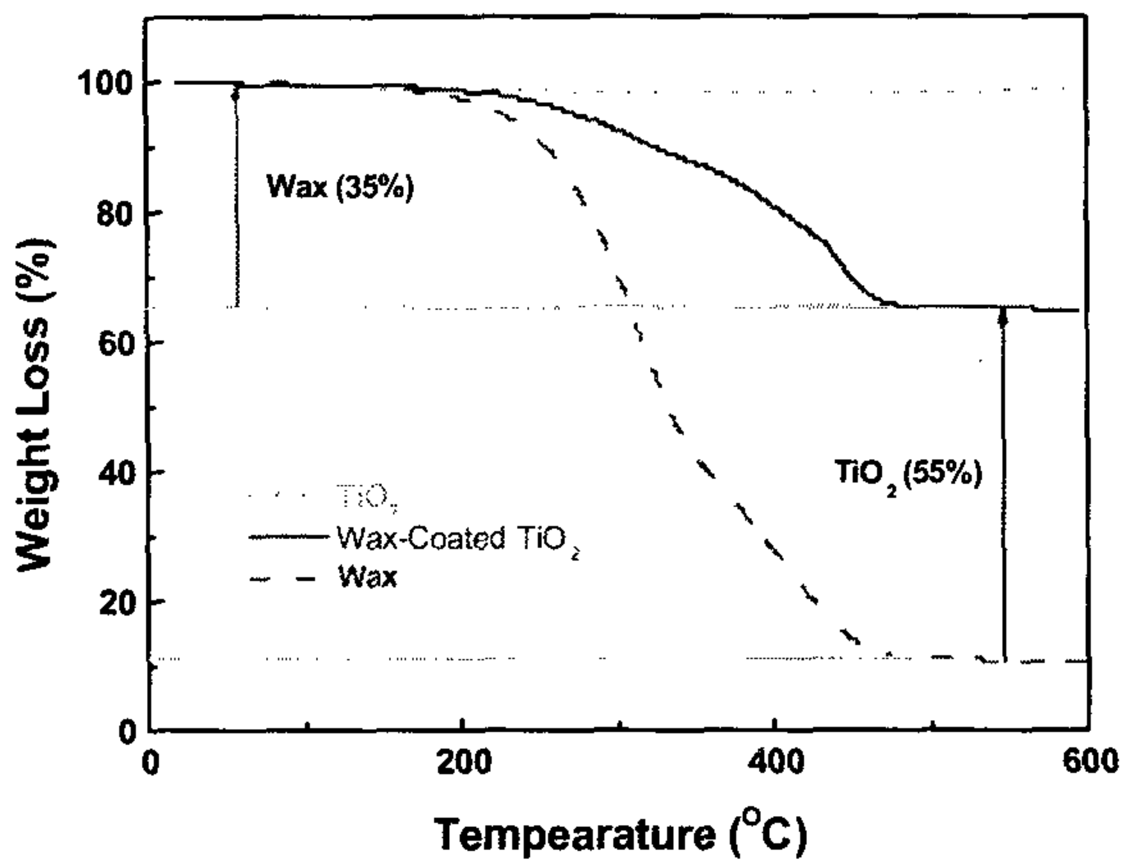

Figure 4. TGA of the bare TiO_2, used wax and wax coated TiO_2 particles. Heating rate used was 5°C/min with N_2 flowing.

Table 1. The comparison of the particle mobilities and zeta potentials of the bare TiO_2, wax Coated TiO_2, and wax coated TiO_2 with CCA.

	Zeta Potential (mV)	Mobility ($\mu m^2/Vs$)
Bare TiO_2	75.7	580
Wax Coated TiO_2	49.0	380
Wax Coated TiO_2 + CCA	-43.5	-330

3. Conclusion

In this study, we have investigated a simple process of preparation of white pigment particles by physical coating with functionalized wax for the electrophoretic display. The techniques for the monodispersed, narrow size distributed pigment particle preparation by using appropriate dispersant or the reaction vessel design considering efficient mixing and dispersion during the coating process are still under investigation. We will discuss, especially, the implementation of bistable pigment providing high mobility by using unique charge control agent and also optical properties of wax coated TiO_2 particle in the future.

4. Acknowledgements

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5. References

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