Microcapsule Electrophoretic Display Method Using Ion Projection Head

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Abstract

"Digital Paper" was recently proposed as a new medium that offers the advantages of both softcopy and hardcopy. Electrophoretic displays are a promising approach to the digital paper medium. This study aims at to confirm their ability as digital paper. We prepared a microcapsule electrophoretic display as the medium and an ion projection head as the driver; clear white images on a blue background were achieved. As digital paper, this medium offers the significant benefits of non-contact writing by ion projection, ease of manufacturing, and physical flexibility.

Introduction

The consumption of paper continues to increase even though more information is now digital. This is because paper has important advantages that are not available with other display media. The concept of Digital Paper was recently proposed[1] as a new medium that combines the advantages of softcopy (display) and hardcopy (paper). Microcapsule electrophoretic displays with ion projection imaging were studied to realize Digital Paper.

Experimental Method

Writing and erasing experiments were carried out using an ion projection head. The principle of the electrophoretic display[2,5,6] using ion projection is shown in Fig. 1. Images are formed on the surface of the electrophoretic sheet by the electric charges formed by ion projection.

The experimental apparatus used in image formation experiments is shown in Fig. 2. A microcapsule electrophoretic sheet, attached to a stage moving at constant speed, was written by the controlled ion flow from an ion projection head[7] above the stage. The resolution of the ion projection head was 300 dpi. The stage speeds were 5 and 10 mm/sec. The distance between the ion projection head and the display sheet was about 1 mm. Image erasing experiments were carried out using uniform charging from a corotoron.

The microcapsuled electrophoretic sheets[3,4] were prepared by applying the microcapsuled electrophoretic medium on transparent PET films, which have electric conduction layer of ITO. Titanium oxide was used as a material of moving particle, and anthoraquinon was used as a blue liquid in the capsules. This system realizes a display with white image in a blue background or blue images in a white background. The mean diameter of microcapsules was 50 x 10^{-3}mm.

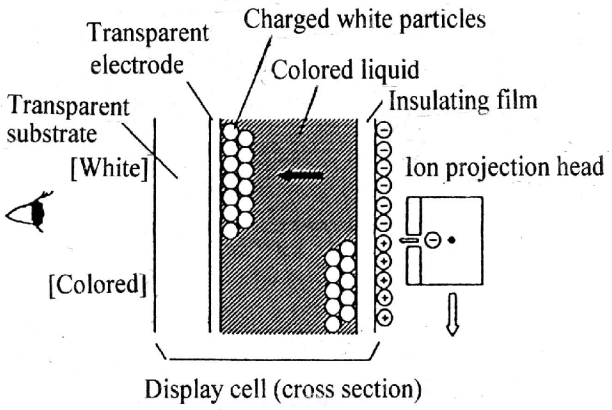

Figure 1. The structure and imaging principle of electrophoretic display.

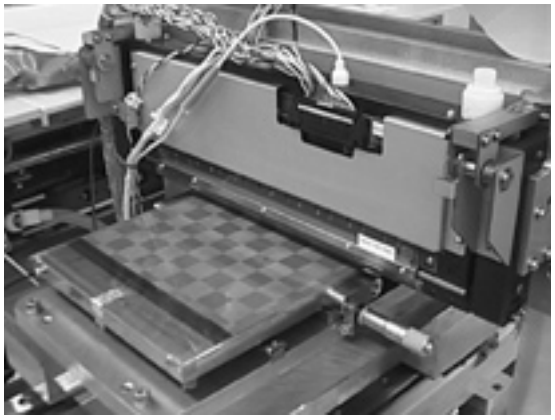

Figure 2. Experimental apparatus

Experimental Results

A typical image formed is shown in Fig.3. Fig.4 is an enlarged portion of Fig.3. Surface potential of image area was measured to be less than 10 V, some 10 sec after ion projection.

Typical optical densities (measured) are shown in Table 1. The contrast ratio of these images was 3.3 (linear scale) as calculated from measured cyan density. Image erasure was achieved by uniform ion projection for 1 second using a corotoron (voltage: 6.75 kV, currents: 0.09 mA).

The overview of the electrophoretic medium in Fig. 5 demonstrates its flexibility; it can curled up like paper.

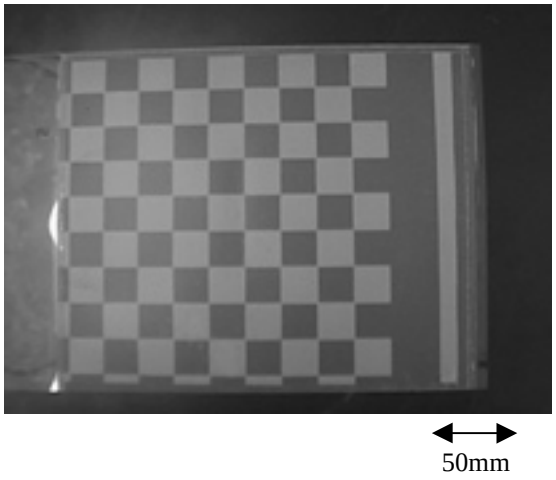

Figure 3. Formed image on microcapsule electrophoretic display sheet

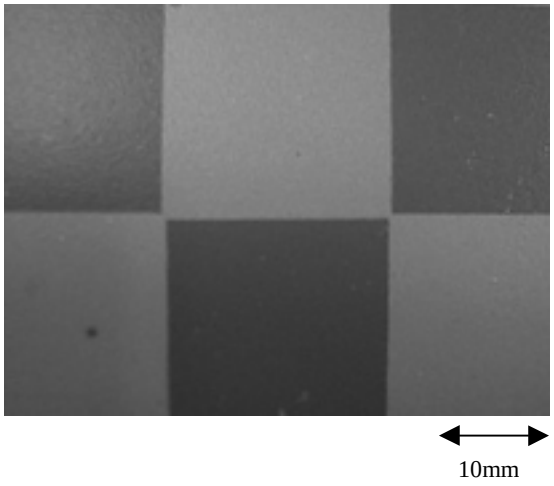

Figure 4. Enlarged portion of formed image

Discussion

Test results confirmed that the microcapsule electrophoretic sheet supported image formation and erasure using an ion projection head and an erasing corotoron. Slight image degradation was observed one week after image formation. Image holding characteristics of the electrophoretic sheet without surface charge should be studied in relation to this image degradation phenomenon. It was confirmed that the surface potential decreases to 0 V just after image creation.

Given the physical weakness the current device, some kind of protection layer will be needed for practical use. The microcapsules can be ruptured if the sheet surface is scratched.

Table 1 A result of image density measurement

	Formed Image A	Back Ground B	Contrast ratio	
			Log scale (B/A)	Linear scale $10^{(B-A)}$
OD (Black)	0.98	1.37	1.40	2.45
OD (Cyan)	1.20	1.72	1.43	3.31

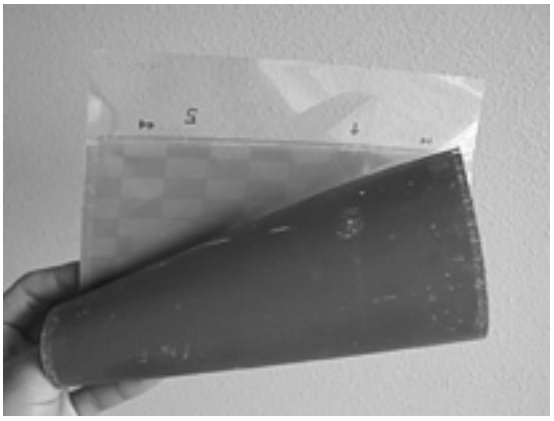

Figure 5. An overview of the microcapsule electrophoretic display sheet.

Summary

Image formation and erasure experiments on a microcapsule electrophoretic sheet using ion projection head and corotoron were performed. Main results are shown as follows.

1) Image formation on a microcapsule electrophoretic sheet was realized using ion projection head.
2) The contrast ratio of white images against a blue background was 3.3 which compares well with paper documents.
3) It was confirmed that the preservation of images on the sheet was realized with no surface electric charges.
4) Image erasure was well completed using corotoron.

The feasibility of realizing digital paper with micro-capsule electrophoretic devices and ion projection was thus confirmed.

References

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Biography

Kazuya Ogura was born in 1977. He entered Department of Electro-Photo Optics in Tokai University in 1996. He is now engaged in the study of Digital Paper.