New erase head for thermal rewritable media

Jiro Oi, HIT Devices, Ltd., US Office, Brentwood, Tennessee, USA, and Hideo Taniguchi, HIT Devices, Ltd., Kyoto, Japan

Abstract

Thermal rewritable technology has been around for nearly a decade but market acceptance has been much slower than anticipated in the US. The rewritable usages are often seen in Japan and Europe for such applications as loyalty/points cards, hotel guest door key cards, train system pre-paid passes and ski passes.

There is a new application being promoted in Japan which combines RFID and thermal rewritable technologies. One of the major obstacles in RFID today is the cost of media - if the media can be reused, the per-usage cost can go down. The electronic data on the memory chip can be updated very easily while visual data such as alpha-numeric and bar code information update is difficult once it is printed with conventional printing technology. This is where rewritable technology comes in. A new application is for the RFID label with thermal rewritable capability.

One of key components in thermal rewritable technology is the eraser. The presentation is about the newly developed 6-inch version thermal erase head in order to accommodate the new application's requirements. Erase head can be heated on demand, while other traditional erasing devices such as heat rollers have to be kept hot always.

Introduction

Direct thermal (DT) printing is one of the simplest and most reliable technologies today. The technology has been around for several decades and it is considered to be a "mature" technology. However, there has been a new development in this technology for the last several years which is called thermal rewritable (TR) technology.

The major difference in key elements between the typical DT printing and TR printing is the print media and the erase head. While printing on DT media is permanent, the TR media printing is reversible. The thermal rewritable media can be printed and erased several hundred times. Currently, the TR media is available from two companies – Mitsubishi Paper Co., Ltd. and Ricoh Corp. The thermo-chemical process on the rewritable print media (leuco dye type) is shown graphically on Figure 1 [1].

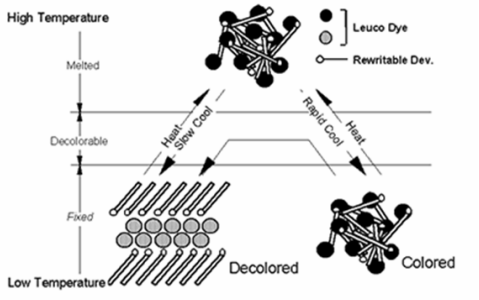

Figure 1
Thermo-chemical process on the rewritable print media

In general, both the TR and DT media colors around 170 °C. However the TR media requires rapid cooling for the image to stay and slow cooling for the image to disappear, while the DT media is indifferent to the cooling profile for the image coloring.

Since printing and erasing are achieved strictly through a thermal process with different heating profile, it is imperative to monitor and control the erase head heater temperature during the erasing process in order to obtain good erasing results which contribute to prolonging the media life and environmentally-friendly & safe operation.

Up until the creation of this erase head, there was no device which can accurately measure the actual temperature of heat element while the media is going through the erasing process.

Features

A new type of erase head was developed in order to meet the requirements for the thermal rewritable application. The material with positive temperature Coefficient of Resistance (TCR) of 1500 parts per million per degree Celsius (ppm/°C) was used for the heat element of the erase head. This material enables the actual temperature of the heater to be measured by monitoring the current change and converting to the change of temperature. Also, the new erase head has a means of measuring the approximate temperature of the media which is in contact with the heat element in real time.

Structure

Figure 2 shows the structure of the new erase head. One of the major differences between the erase head and the regular thermal printhead is that a suitable thermal insulation layer can be inserted between the heat generating ceramic substrate and the heat sink based on the application and thermal characteristic requirement. Another difference is that there is a substrate temperature sensor element along the heating element on the ceramic substrate.

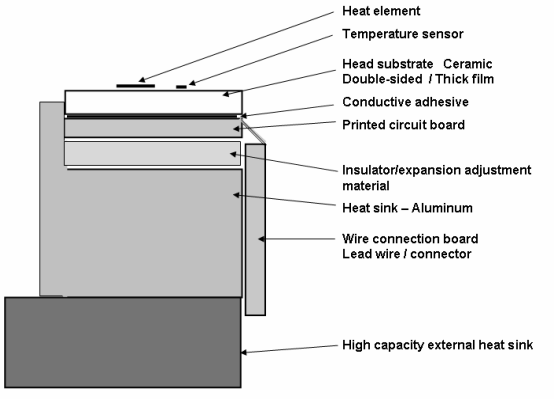

Figure 2
Erase head cross-sectional view

Erase head characteristics / temperature characteristics measurement method

Heating characteristics

The temperature rise increases the resistance value and power decrease occur when the DC voltage is applied to R1 are shown on Figure 3. The temperature of heat element (R1) can be monitored by measuring the change of the current when the power is applied. The substrate temperature can be monitored with R2 resistance measurement when the voltage is not applied to R1 as shown on Figure 4.

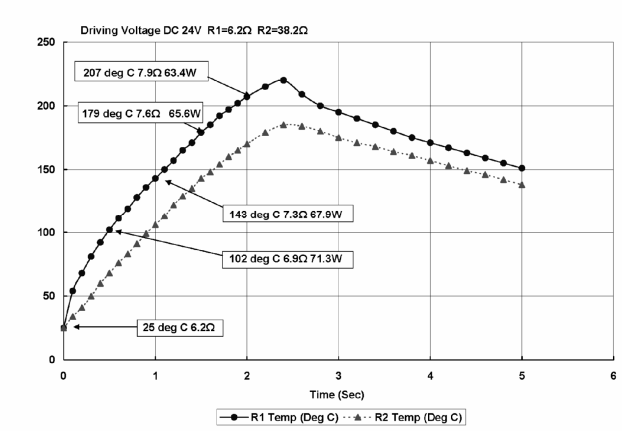

Figure 3
Erase head power-on characteristics

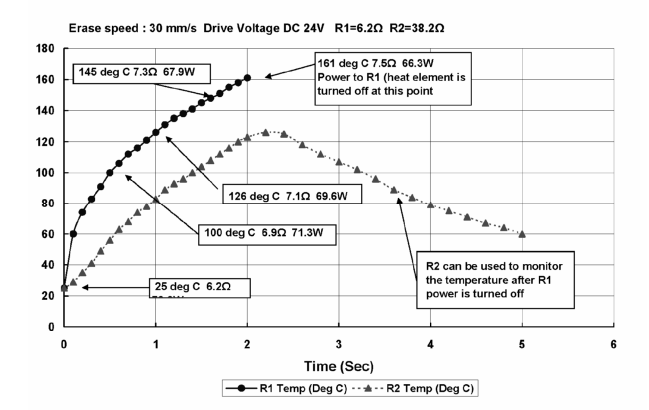

Figure 4
Erase head power-off characteristics

Structure/Driving method

As shown on Figure 2, the erase head is made with the thermal insulation layer which optimizes the heating and cooling erase head to maximize the erasing operation. This structure allows the erase head to be heated on demand so that it can be turned off while the erasing process is not in operation which reduces excess heating, material degradation due to excessive temperature, wasting energy while on stand-by status and also eliminates the thermal hazard.

Temperature Verification

As a head evaluation tool, a special thermal sensitive paper was prepared in order to verify the change of temperature visually and also to see the unevenness of media heating. The feature of this test paper is that the optical density of the printed image change based on the temperature is gradual and fairly linear unlike a typical thermal sensitive paper available on the market for POS receipt or label printing. This characteristics makes it easy to estimate the temperature of the heating element which is in contact with the paper. Typical characteristics are shown on Figure 5.

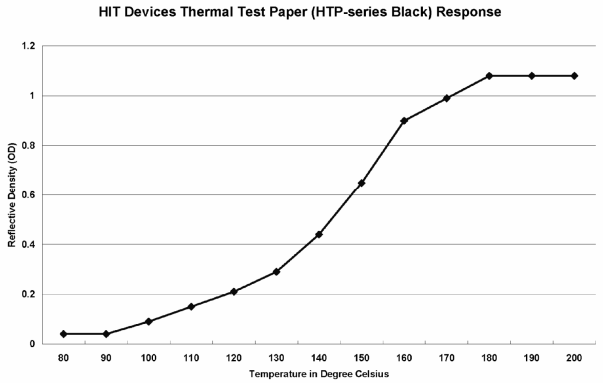

Figure 5
Test paper characteristics

Evaluation of erase head

The special thermal sensitive paper mentioned above was used to evaluate the erase head. The temperature variation and unevenness are clearly seen on the paper. The two printout samples shown on Figure 6 were taken at 30 mm/sec and 60 mm/sec erase speed.

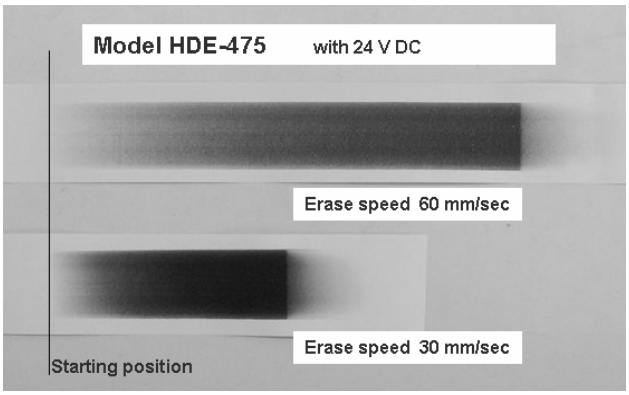

Figure 6
Head evaluation with special paper

Evaluation of rewritable media characteristics

Although both rewritable media companies supply technical data and information, it is difficult to compare the thermal characteristics using the same criteria. Since the industry-wide standard notation of coloring and erasing characteristics are not available, our own evaluation and quantification of the characteristics were conducted. Figure 6 shows the typical evaluation results of rewritable media at various printing and erasing temperatures. The results are characterized and graphs for each media types from two companies are prepared in order to be used for optimizing the erase head function.

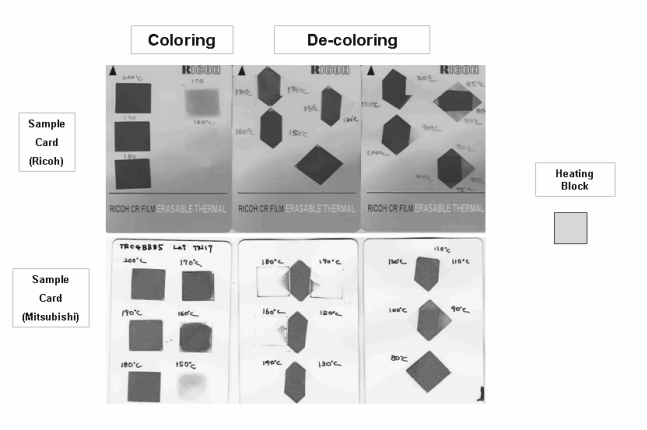

Figure 7
Rewritable media evaluation

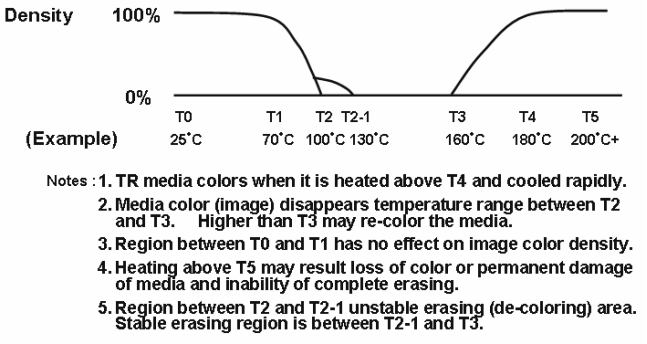

Figure 8
Characterization of rewritable media

Conclusions

Improvement of erasing quality

The rewritable media can be damaged irreversibly if the conditions are not right. Excessive heat, for example, will leave a permanent mark on the media even if the erasing process is done properly. Therefore, the printing conditions have to be optimized to meet the rewritable media requirements. The same conditions are required for erasing process. The quality of erasing will change depending on temperature variation within the erase head due to the head structure and the method to control the temperature. When the printing and erasing process are performed correctly, the rewritable media should be "restored" to the conditions before the image was printed. The new thermal erase head, with the capability to heat the rewritable media on demand and to be able to measure the temperature in progress should contribute greatly to the rewritable printing industry.

Implication with other technologies

Thermal rewritable technology has been around for more than a decade and its usefulness has been demonstrated as a stand-alone venture with card-related business although it has not been really accepted in the US market in large scale.

The new applications are emerging in concert with other technologies which may have a much larger implication than the past activities. RFID, in particular, has been touted as a very promising and useful technology in the last several years. However, it has not come to fruition as many have expected. The bottle-necks have been :

Cost of media : The more data inputted on the RFID media, the more cost it incurs. Volume efficiency of mass production at this point will not the affordable threshold level which some define as 5 Cents per label.

Visibility of current data : The information or data on the RFID media with IC can be changed easily. However, human readable data remains unchanged usually.

If the RFID media can be rewritten in both electronic format and human readable format, then the above problems can be solved. The thermal rewritable technology can establish a "symbiotic" relation with RFID to be mutual benefit.

Newly developed erase head will contribute the improvement of thermal rewritable printing technology with on-demand erasing, conservation of energy, keeping the component at lower temperature and preventing heat-related hazardous situation.

References

[1] Courtesy of Mitsubishi Paper Mills Limited - ThermoRewrite®
Mitsubishi Paper Mills Limited

Author Biography

Jiro Oi, native of Hokkaido, Japan, received his BSEE from California Polytechnic State University and MBA from the Thunderbird Garvin International School of Management (aka American Graduate School of International Management.) He worked for Hitachi Sales Corp (in Japan and US) and ROHM Electronics (US subsidiary of ROHM Co., Ltd.) before joining HIT Devices Ltd, Kyoto, Japan-based company specialized in high-technology components. He is a Director of Afit USA also. Currently he resides in Brentwood, Tennessee.

Hideo Taniguchi received his BS from Ritsumeikan University in Applied Chemistry with additional study in Electrical Engineering. He worked for ROHM Co., Ltd. in Kyoto Japan over 40 years in development and mass-production project of numerous products including items relevant to printing industry such as thermal printheads with thick and thin film technology (thermal printhead with partial glaze layer, development/implementation of dedicated driver IC on substrate for thermal printhead and development and launching LED printhead mass-production at ROHM) before starting a new company, HIT Devices, Ltd.