New Erase Head for RFID Thermal Rewritable Media

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Abstract

Although thermal rewritable technology has been known in the printing industry for about a decade, it has been used mainly for card applications only in Japan and Europe. Usages in other applications have been less than anticipated for various reasons.

Radio Frequency Identification (RFID) technology has been around much longer than rewritable technology, but its usages have been becoming popular in the last several years.

A new application is emerging which utilizes both of those technologies in industrial manufacturing operation known as "just-in-time" (JIT) Kanban System. Using RFID for Kanban media makes the operation more efficient as the information on the card can be retrieved beyond bar-code scanning range and electronic data on the media can be updated. One issue with electronic data on the media (card or label) update is that the media needs to be reprinted if the visible information (such as alpha-numeric and bar-code) needs to be updated while electronic data can be changed easily and almost endlessly. Regular media with memory IC chip is rather expensive and single use (print-and-discard) process is uneconomical. This is where the rewritable technology comes in, since the media can be reused (rewritten) several hundred times -- the cost becomes almost a non-issue.

HIT Devices, Ltd., developed an erase head specifically designed to meet the requirements of this application.

Introduction

Thermal rewritable technology similar to direct thermal printing technology where the thermal sensitive media which contains chemical is heated with the printhead and permanent image forms.

The difference is that the thermal rewritable media is coated with a different type of material which forms an image, but the image can be erased for several hundred times. Currently, the thermal rewritable 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].

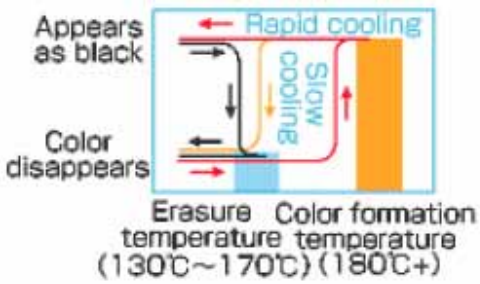

***Figure 1**. Thermo-chemical process of rewritable media*

Printing on thermal rewritable media is similar to direct thermal printing, but erasing is accomplished through heating the media with different thermal profile from printing. In essence, the printing (coloring) profile needs to be heating and cooling in short duration while erasing (de-coloring) requires slow cooling within a narrow window of temperature range. Although both companies use similar materials, there are some differences among their thermal rewritable materials and it was necessary to run our own evaluation in order to find the optimum erasing condition range as shown on Figure 2.

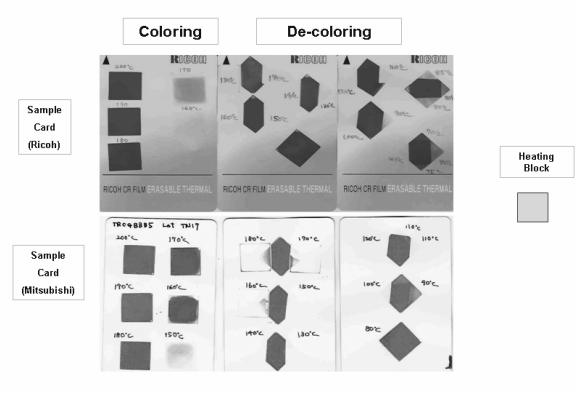

***Figure 2**. Rewritable media evaluation process*

The results were tabulated in the form shown on Figure 3.

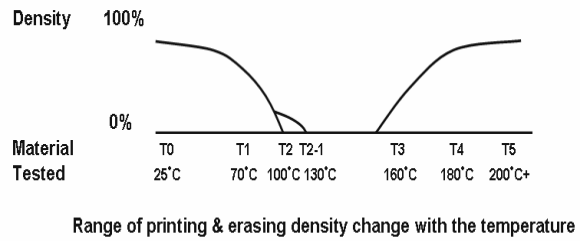

***Figure 3**. Example of rewritable media evaluation data tabulation*

Monitoring and controlling the erasing temperature is a main factor to obtain good erasing results. From an application point of view, combining thermal rewritable technology and Radio Frequency Identification (RFID) technology is a perfect case of symbiotic relationship in the high-tech world. The major bottle-neck with RFID technology's progress has been the cost of media (label/tag with IC chip and antenna) being too high. Industry

consensus today is that the threshold cost of media is 5 Cents before RFID takes off.

Rewritable RFID media has other benefits over the single usage (print-and-discard) media. Data will be more secure if the label is reused rather than discarded since the label stays "in the system". Also, it is more "environmentally friendly" as the label is not discarded. However, it requires the label to be retrieved for erasing/reprinting and that may restrict the application and this is not every RFID situation.

Today, Kanban System is becoming popular as a part of "just-in-time" process in manufacturing environment and the RFID Kanban is the latest trend. Since the Kanban format is larger than the typical credit card size, single usage material cost is a big issue.

Usage of thermal rewritable media with the RFID circuitry makes an ideal match for this situation as it can be rewritten several hundred times.

The challenge for the erase head manufacturer is to come up with the product to erase the printed image cleanly, quickly, safely and economically.

Features

Having visible information (alpha-numeric and/or graphic information as well as bar-code) which is consistent with the electronic data on the RFID is very useful and it is becoming one of the key points in efficiency increase in industry. It is a part of the widely accepted kaizen (improvement) movement in Japan called "*mieruka*" (visualization). Our contribution to the cause is to develop a new erase head to meet the requirements for the RFID Kanban thermal rewritable application. The erase width is 210 mm to accommodate the A4 format. Erasing speed needs to be 100 mm/sec or 4 inch-per-second (ips). In order to have better control of erasing temperature, the heating element and temperature sensing elements are made of a material which has a positive thermal coefficient of 1500 parts per million per degree Celsius (ppm/°C). This makes the real-time temperature monitoring of heat element and head substrate possible with the head in contact with the media – this is a feature not seen in the existing erase head products. The erase head is powered on-demand which makes it safer, more economical and environmentally friendly compared with other devices for the same function such as heat roller which is turned on continuously.

In conjunction with the erase head, we have come up with the thermal sensitive test paper which has gradual and fairly linear temperature response curve. The heat generated by the erasing element may not transfer to the media surface completely due to various reasons such as misalignment or insufficient head-media contact pressure. The surface temperature can be estimated from the optical density of the image on the paper. Figure 4 indicates the location of temperature monitoring points.

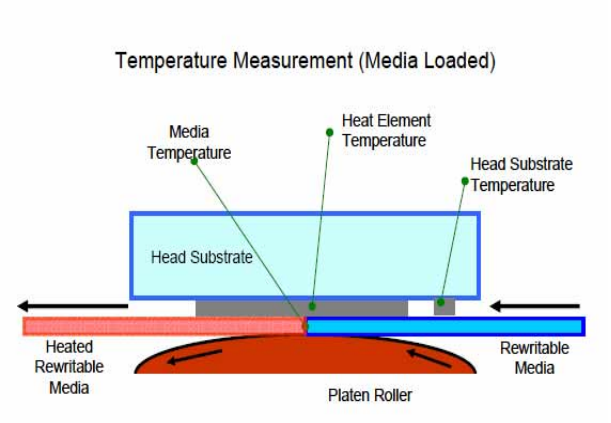

***Figure 4**. Temperature monitoring points*

Structure

When the erasing speed becomes faster, more power is required to keep up with the erasing energy. That can be seen from the multiple temperature monitoring points. Figure 5 shows the relationship between the speed and temperature (head substrate). The temperature of heat element can be monitored by measuring the change of the current when the power is applied. This information is used to optimize the driving condition of the erase head.

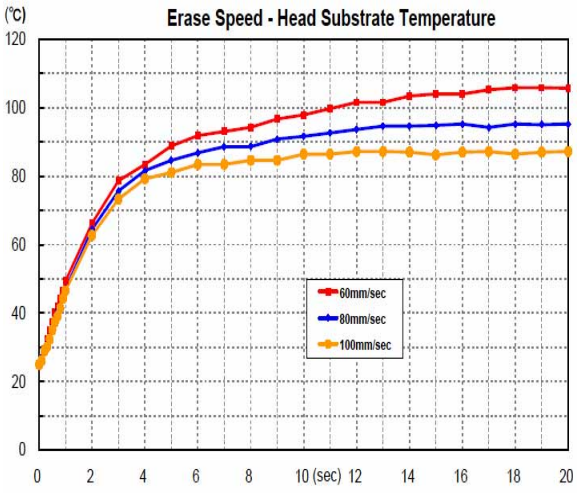

***Figure 5**. Erase speed and temperature (substrate)*

As the erase head heating element is powered on and off, the head ceramic substrate temperature goes up and down which results in the expansion and contraction of substrate. For example, going from room temperature up to 150 °C on an A4 size substrate results 0.2 mm elongation. The head structure was designed to accommodate the lateral dimensional fluctuations as shown on Figure 6 by incorporating intermediary layer and flexible adhesive layers.

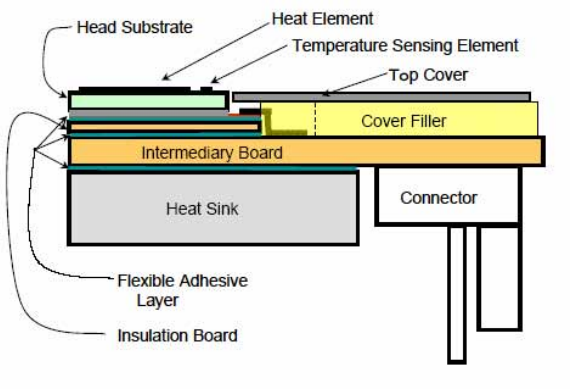

***Figure 6**. Erase head side view*

Temperature Verification

The temperature of heat element and head substrate can be measured, but the most important requirement is to know the temperature of the media surface. So, the verification of actual media surface temperature is useful as the temperature control is very critical for good erasing result. The special thermal sensitive test paper HIT Devices Ltd., developed is used for this purpose in place of the rewritable media. The surface temperature is verified from the optical density of the image on the paper. Also, any irregularity on the erase head surface which affects the erase quality can be detected by using the paper.

Conclusions

Multi-industry process such as thermal rewritable printing and RFID with JIT Kanban System may be analogous to a gear wheel. Erase head is just a part of a large system or a tooth of the gear – by it alone, it can not accomplish much. Without it, however, the wheel will not turn.

Our RFID Kanban rewritable tag compatible erase head will contribute to the improvement of thermal rewritable printing technology with on-demand and high-speed erasing capability (conservation of energy by keeping the component at lower temperature while not in use and preventing heat-related hazardous situation)

References

[1] RECO-View™ TR Product Technology Information by Ricoh http://www.ricoh.com/thermal/product/tr/tr_technologies/

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.