

MF (Multi-Function) Cathode for High Current Density CRT

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Abstract

A limitation of oxide cathode is the high current density, caused by low electrical conductivity of an emitter layer. This limitation can be overcome by increasing the conductivity, and uniform dispersion of Ni powder and pore agent could be achieved by using the screen-printing method. This new cathode has shown not only high current density reliability but also improved performance characteristics and as such given the name "Multi-Function cathode". It is expected to be a good replacement of the impregnated cathode.

Keywords : oxide cathode, MF cathode, high current density, print cathode, CRT cathode

1. Introduction

Recently, there has been an increasing demand for a high current density emitter needed to achieve high screen brightness and high resolution in large-size CRTs. In this case, in spite of high cost and complicated manufacturing processes, most of the CRT makers are using impregnated cathodes.

However, the impregnated cathode has some limitations such as complicated manufacturing processes and high cost, making it difficult to change oxide cathodes into a main stream.

Numerous attempts have been made to improve the performance of the oxide cathodes, such as increasing conductivity of the emitter layer.

The added acicular conductive Ni powder in a cathode emitter layer has already been verified to show good performance and long lifetime.

However, in spite of these merits, mass production of has not been successful yet, because of spray nozzle clogging and non-uniform Ni distribution in the oxide paste layer due to its specific weight differences as shown Table 1.

To solve these problems, we adopted a screen-printing method that has been used in the silk-screen process. To adopt the screen-printing method, emitter layer substance condition should be changed from suspension status to paste status of printable viscosity.

Table 1. Specific gravities for the paste solid materials

	Carbon Oxide	Ni Powder	Pore Agent
Specific Gravity	3.97	8.85	1.36

The mixture of conductive metal powder and pore agent should be proper ratio and in uniform distribution.

Applying the screen-printing method, by using acicular Ni powder and pore agent to a novel cathode, we could obtain a highly reliable oxide cathode under high current density condition. We also observed improved moiré and focus characteristics when the roughness of the cathode surface, which makes the beam shape more Gaussian distribution was reduced. In addition to this manufacturing cost was reduced by reducing the material waste from 90 % to 30 % in the carbonate mixture.

In this paper, we will describe our novel cathode, by emphasizing on the stable way of performing carbonate paste formation and on the long lifetime characteristic at high current density.

2. Cathode Structure

An oxide cathode with a generic emitter usually

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display a short lifetime characteristic at high current density. The thermal-resistance that is generated by the emission at high current is known to be one of the main destructive factors of the emitter layer.

In the new emitter layer, acicular conductive Ni powder showed a unique three-dimensional, chain-like network of fine particles and played a important role in decreasing thermal-resistance at high current density.

To use acicular conductive Ni powder, we developed a screen-printing layering method from the conventional spraying method; to ensure the dispersion of a mixture of Ni powder and pore agent as stabilized.

For a screen-printing process, the viscosity of carbonate solution should be increased to a paste status and a dry process follows after the printing process to evaporate vehicle and pore agent.

Fig. 1 shows the difference in the layering method between spraying method and screen-printing method. In the screen-printing process, a lump of paste is squeezed out and pushed through the mesh (or screen) holes, so that the cathodes under the mesh is coated with the paste as shown in Fig. 1.

The density and thickness of the emitter layer in a printing cathode are similar to those of the conventional spray cathode. These parameters are controlled by the paste viscosity, which in turn is controlled by the pore agent amount.

This novel cathode paste consists of carbonate, conductive metal powder, pore agent, complex LaMg compound and vehicle. Compared with the conventional cathode, the differences are the pore agent that makes electron emission easy, and the conductive metal powder that reduces thermal-resistance generated under high current condition. In selecting the pore agent, the decomposition characteristics has been considered, no residuals after decomposition and no harmful gas to the electron emission

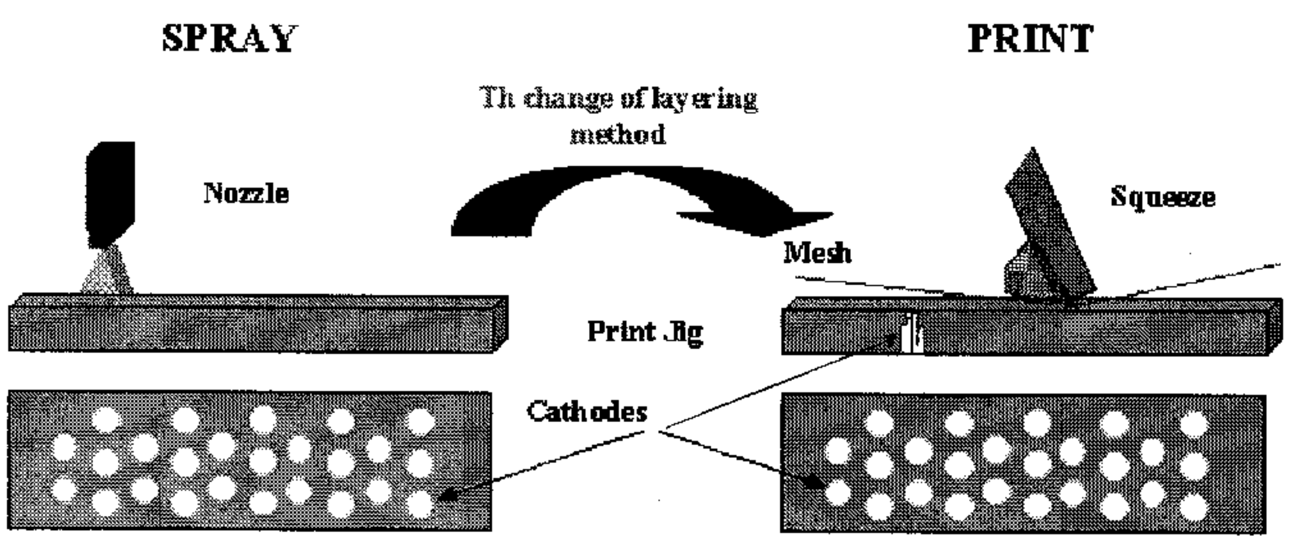


Fig. 1. Difference between spraying and screen-printing.

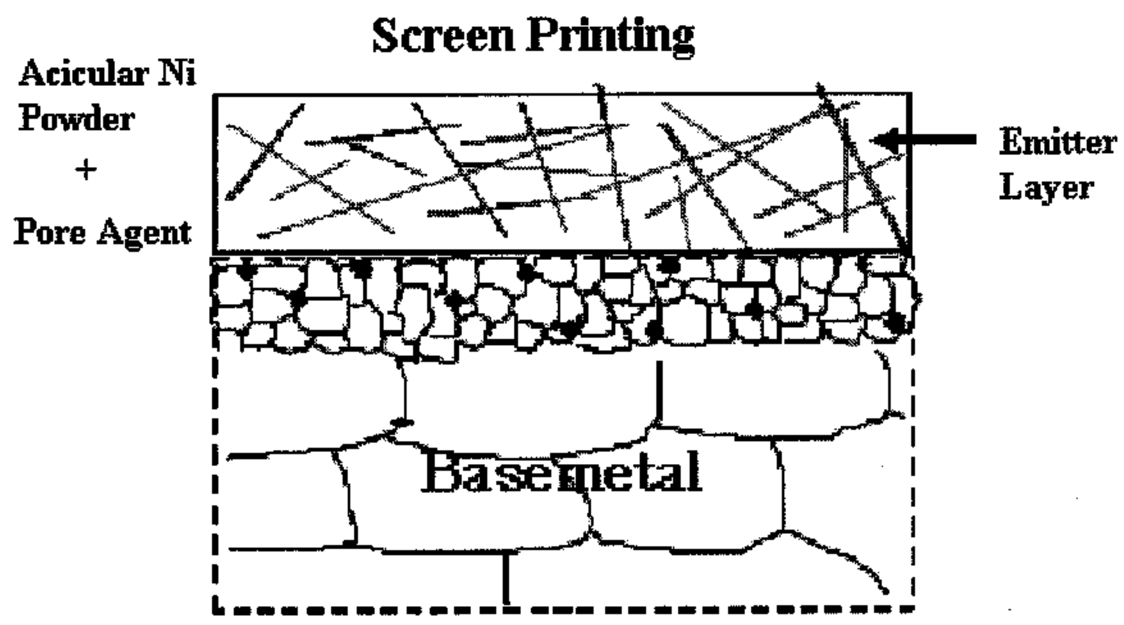


Fig. 2. Cross-sectional view of new type cathode.

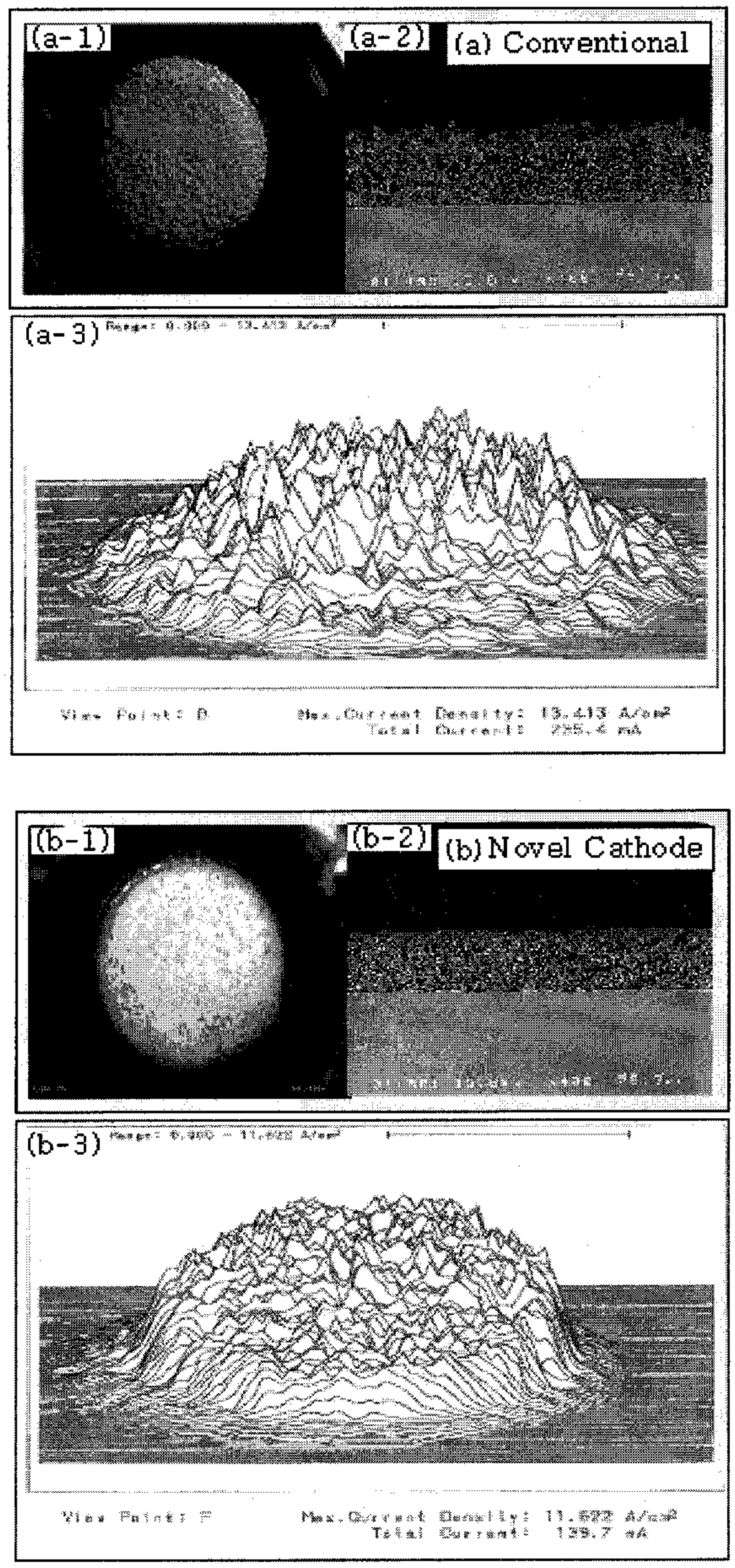


Fig. 3. Comparison of Beam Profile Characteristics: Conventional cathode (a1) surface (a2) the cut end (a3) beam profile New Cathode (b1) surface (b2) the cut end (b3) beam profile.

in a low temperature.

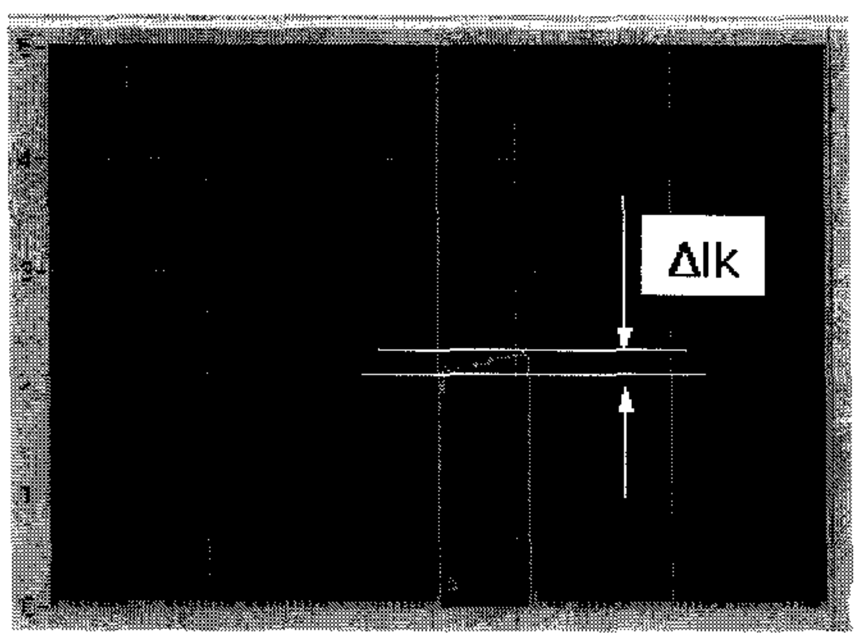
Fig. 2 shows the cross-sectional view of the novel cathode. Carbonate paste that compose of a mixture of acicular Ni powder and pore agent is printed on the base metal.

Fig. 3 shows the comparison of a new screen printed cathode and a conventional cathode. The cathode emission profile was measured by diode style and the new cathode surface roughness was found to be smoothened from 18 μm to 5 μm.

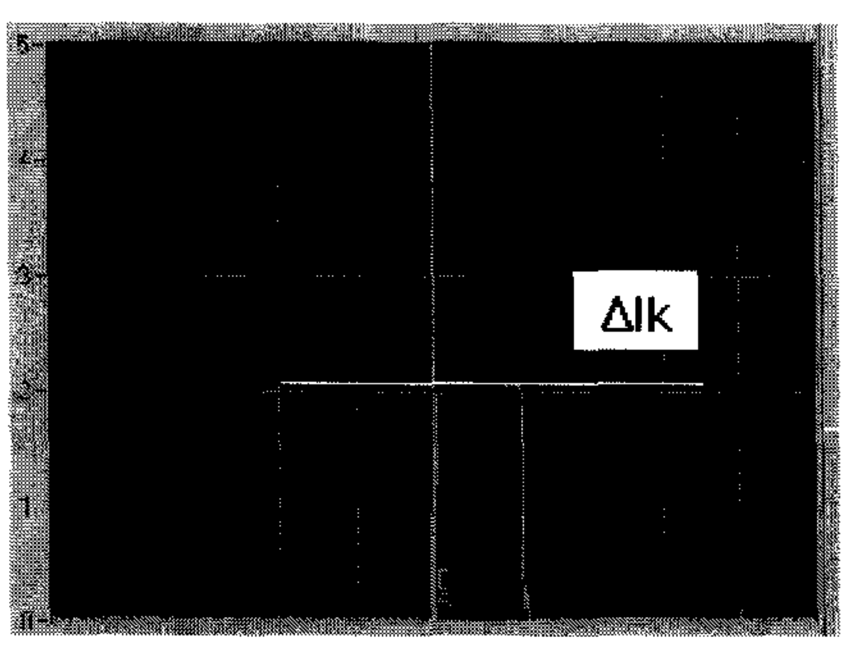
Fig. 3 (b2) and Fig. 3 (b3) show the improved emission profiles.

Fig. 4 is a comparison of pulse emission test results. The pulse emission test evaluates the distortion of input versus the current. The test result of the conventional cathode in Fig. 4(a) shows an increased current from the initial Δ Ik, while the new cathode in Fig. 4(b) shows a negligibly small Δ Ik. Cased on this result, we can conclude that the emission layer's low conductivity in a conventional cathode was the cause of the current increase, that resulted in large Δ Ik.

This novel cathode paste contains conductive metal Ni powder that can reduce thermal-resistance. This helps to prevent unstable emission from occuring, which in turn, contributes to novel cathode in achieving longer life emission reliability.



(a)



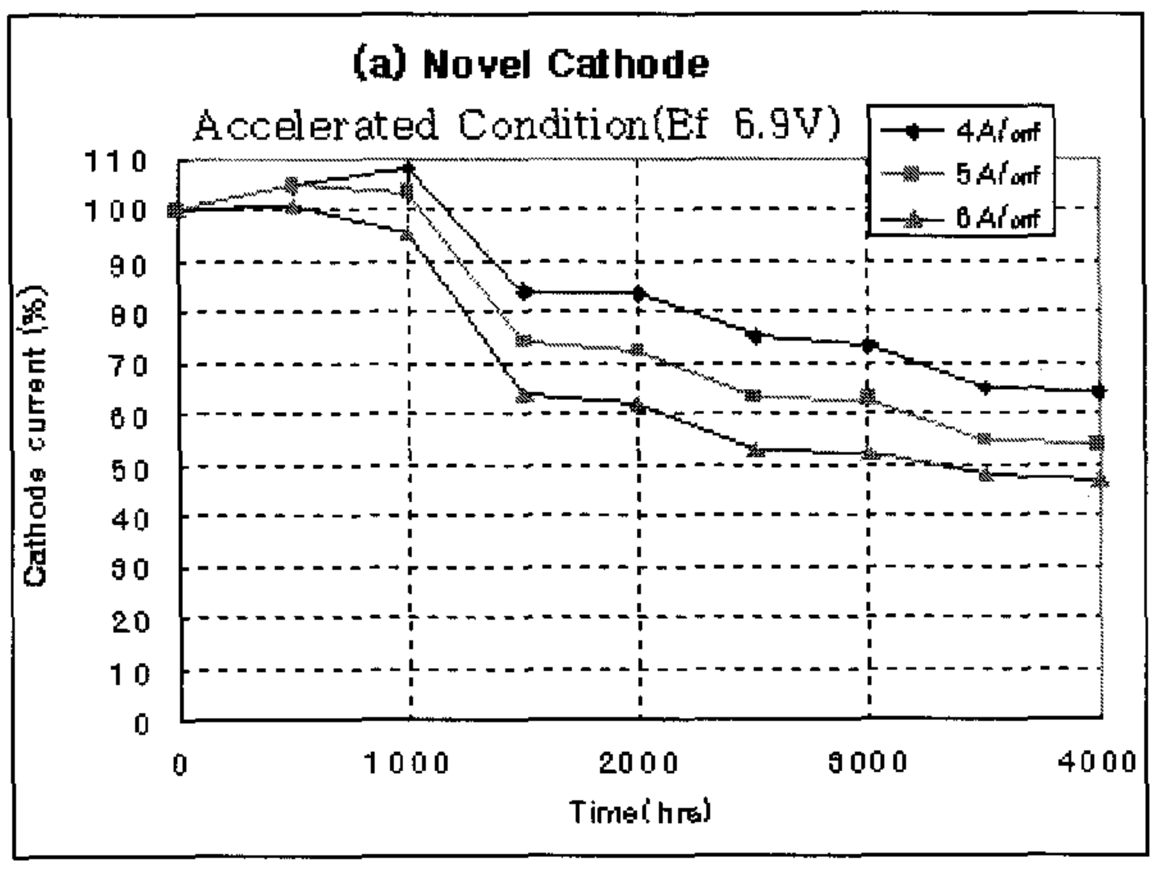
(b)

Fig. 4. Results of pulse emission test: (a) conventional type and (b) novel type.

3. Lifetime Characteristics

The new type cathodes were tested under the same operating condition as conventional cathodes. Fig. 5 shows typical lifetime characteristics of both the novel cathode and the conventional cathode under the various current conditions. The current density for the lifetime test ranges from 4 A/cm^2 to 6 A/cm^2 (Peak current density).

The initial current density level of the novel cathode was set to be the same as that of the conventional cathode.



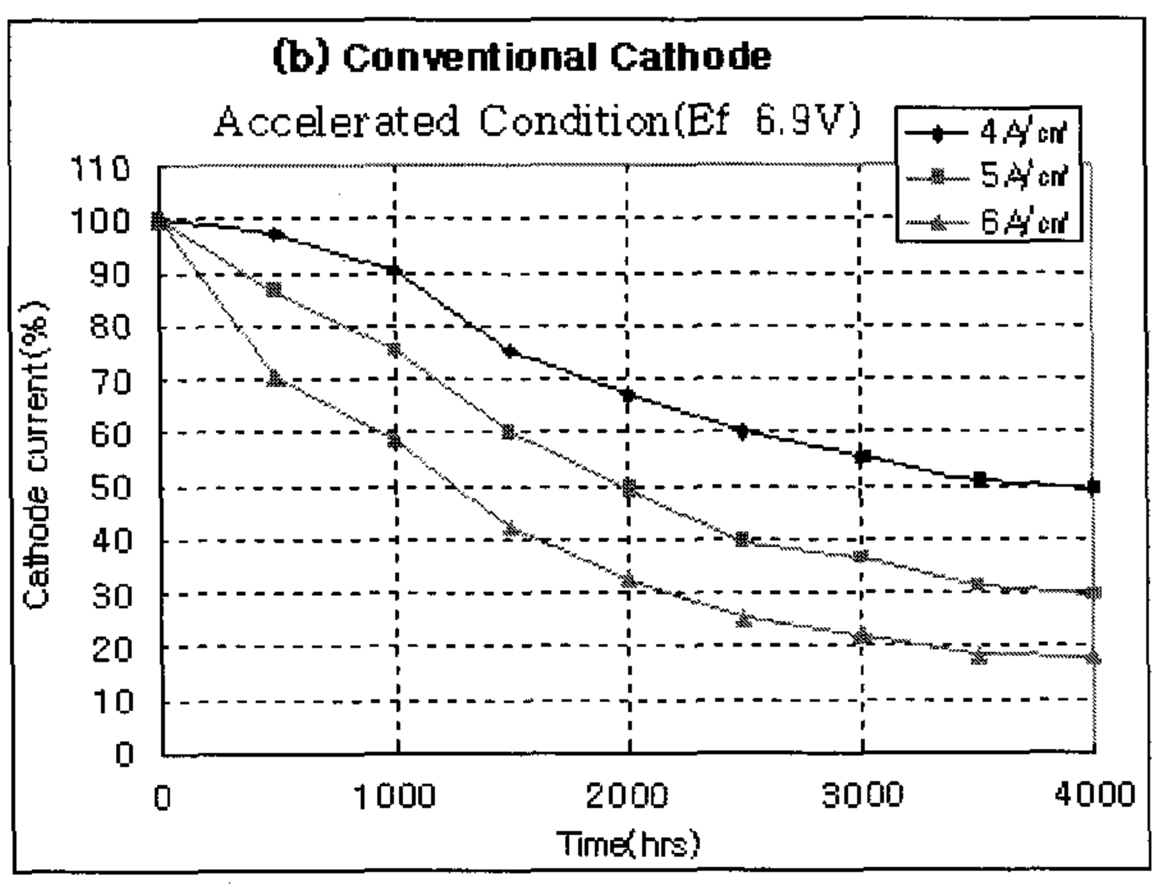


Fig. 5. Lifetime characteristics of the novel cathode and the conventional cathode
(a) Novel cathode Ik remain rate in accelerated condition Ef 6.9 V.
(b) Conventional cathode Ik remain rate in accelerated condition Ef 6.9 V.

As time passes by, the emissions of the novel cathode are higher than those of the conventional cathodes. Even under the higher current density, the emissions in the new cathodes are higher than those of conventional cathodes. This means that the new cathode could be readily used under higher current density.

4. Conclusion

We have developed a new cathode, in which a few key characteristics were remarkably improved with the help of acicular Ni powder in the emitter layer and by adopting the screen-printing process.

Even when the current density condition was about 3 A/cm^2 for conventional cathodes, we successfully developed an oxide cathode which can be used at the current density over 5A/cm. This current density level is sufficient enough for realizing high resolution and the high brightness CRTs.

Moreover, this new cathode has shown to guarantee extended lifetime under a higher current density and became a gorgeous solution for the replacement of an impregnated cathode.

We expect that this cathode will help extend the life of CRT industry.

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