When Methane is decomposed on the CRT Manufacturing Process

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Abstract

Vacuum surroundings in Cathode Ray Tubes (CRT) are very important factor for CRT lifetime, especially cathode & getter's. A getter is a very good vacuum pump; unfortunately, it cannot absorb an inert gas and hydrocarbons. There are only argon and helium in CRT after 1st emission test because other active gases are absorbed by getter and methane is decomposed during CRT working. It is also very important to know exactly where and when methane is decomposed during the CRT manufacturing process, because methane is known to be harmful to cathode when its amount is high, and getter can't absorb the methane.

1. Introduction

Although Cathode ray tube (CRT) technology seems to be quite matured, there are a lot of things to be experimented quantitatively, and to be improved. One of them is vacuum, especially methane in the CRT.

Methane seems to be harmful to cathode as its amount is high due to the ion bombardment and carbon deposition onto the cathode. [1]

Methane is the main gas in the CRT just after getter flashing, however, there is no methane in the final goods because methane is all decomposed.

Therefore, if we know exactly where and when methane is decomposed on the CRT manufacturing process, we can control or deduce an amount of methane, consequently we may improve the initial emission characteristics and lifetime of CRT.

It has been known generally that methane is decomposed on the surface of hot materials, however, it has not been discovered yet clearly when methane is decomposed during CRT manufacturing step. [2]

In reference CRT manufacturing step related with vacuum is shown blow.

Vacuum exhausting ⇒ Tip off (Sealing) ⇒ Ba Getter Flashing ⇒ High Voltage knocking ⇒ Aging (including activation) ⇒ 1st Emission test

A barium getter is a powerful vacuum pump for gases except only inert gases and hydrocarbons. i.e., to deduce the methane below some value may be the key to improve the lifetime of cathode.

2. Experimental

The schematic diagram of experimental equipment is shown as Figure 1.

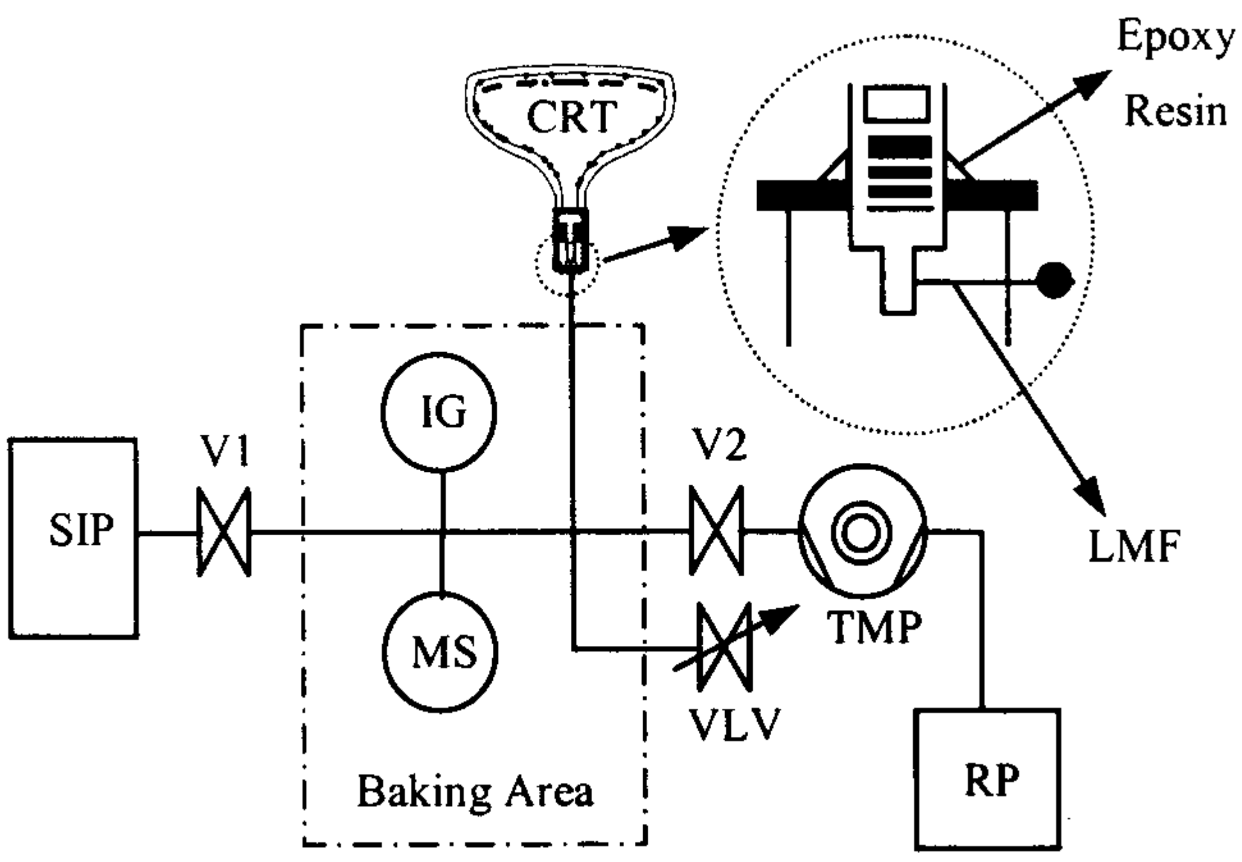

Figure 1. The schematic diagram of RGA
TMP; Turbo molecular pump
SIP; Sputter ion pump
LMF; Linear motion feedthrough
VLV; Variable leak valve
MS; Quadrupole mass spectrometer
IG; Ionization gauge RP; Rotary pump

We used the quadrupole mass spectrometer (QMS) to analyze a residual gas in CRT. We also calibrated RGA with standard high-purity gases, variable micro leak valve and a precision ionization gauge.

A brief experimental procedure is summarized as below.

1. CRT loading onto system with epoxy resin
2. Vacuum exhausting while baking up to ~200℃

3. Making closed system by closing the V1 & V2

4. Breaking the tip of CRT by LMF and analyzing

In this case out-gassing rate of analysis vacuum chamber itself must be extremely low, otherwise it must be compensated properly.

3. Results and discussion

RGA results of 19" normal CRT are shown in Table 1.

	After Exhaust	After Getter Flashing	After Aging	After 1st Emission test
Ar	$2.13x10^{-8}$	$1.02x10^{-7}$	$1.11x10^{-7}$	$1.27x10^{-7}$
He	$8.90x10^{-9}$	$6.79x10^{-9}$	$1.20x10^{-8}$	$1.66x10^{-8}$
CH_4	**$1.37x10^{-4}$**	**$6.32x10^{-4}$**	**$1.41x10^{-5}$**	-
Others	$9.93x10^{-3}$	$1.47x10^{-7}$	-	-
Total	$1.13x10^{-3}$	$6.33x10^{-4}$	$1.42x10^{-5}$	$1.43x10^{-7}$

Table 1. RGA results of 19" normal CRT on he each manufacturing process. Unit ; torr

Pay attention to the change of methane partial pressure. An amount of methane just after aging is not reduced very much, however, after emission methane is wholly disappeared below the lower limit of an analyzer. 1st emission test time is mere ~5 min while the total time of ageing is 50~80min.

Aging process means heating the cathode up to ~1050℃ and drawing the current up to 30~100mA from cathode to G1 and G2 grid in the CRT.

This result is different from the common sense that methane is decomposed on the hot materials. If our experiment is true, methane looks like be decomposed by an activated phosphor or long-path electron beam.

Methane is known to be harmful to cathode when its amount is high. We guess it's same in aging process. i.e., if we can deduce methane before aging without cathode damage, it has possibility to avoid the cathode damage and to improve the cathode lifetime.

4. Conclusion

Methane is decomposed on NOT aging BUT emission; if it is true that lots of methane is harmful to cathode in aging process, and if we can deduce methane below a certain value without any cathode damage, we have a possibility to improve the cathode lifetime. This experiment may give us the hint about that.

Acknowledgments

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5. References

[1] H.J. R. Perdijk, Supplemento Al Nuovo Ciemento, vol.5, no.1. p73, (1967).

[2] Chao-Chin Chen, Kuo-Ching Chou, Chi-Neng Mo, C.H. Tseng and K.C. Chen, Proceedings of the 5th Asian Symposium on Information Display (ASID'99), p250, (1999)