Kogation of Inorganic Impurities In Bubble Jet Ink

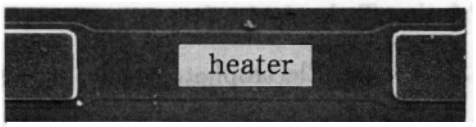
K. Shirota, M. Shioya, Y. Suga and T. Eida
Canon Inc. Tamagawa, Kanagawa, Japan

Introduction

Kogation is the phenomenon that ink ingredients are thermally decomposed and deposited on the surface of a bubble jet heater, and is coined from a Japanese noun "koge" which means scorch, burn, or char. A typical SEM image of a seriously kogated heater is shown in Figure 1. If kogation is serious, koga, build-up of decomposed products, makes the heater surface rough, and causes bubble formation unstable. This instability could lead the droplet velocity low and the droplet volume small, and result in poor printing quality.

Various ink ingredients which cause koga have been studied, including dyestuffs, inorganic impurities, biocides and solvents[1,2,3]. In our experience, dyestuffs and inorganic impurities are main causes of kogation.We have discussed kogation caused by various dyestuffs and found kogation-free dye structures in the previous paper[1].

This paper deals with kogation caused by inorganic impurities. Kogation of various kinds of inks were tested. Inorganic impurities in ink and elemental composition of their koga were analyzed. In addition, inorganic impurities were added to a kogation-free ink and its kogation was examined. The results show that inorganic impurities in ink cause kogation.



(a)

(b)

Figure 1. SEM images of bubble jet heaters. (a): Unused heater (b): Seriously kogated heater

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Experimental

Evaluation of Kogation Level

Kogation level of ink was examined by observing koga on the heater of a bubble jet head. Ink was composed of dyestuffs, glycols and de-ionized water. The ink was ejected from Canon bubble jet head for 107 to 109 pulses which is equivalent to printing volume of 300 to 30,000 pages. After ejection, the heater was removed from the head and its surface was examined by a microscope to judge kogation level.

Analysis of Koga

Elemental composition of koga was analyzed by an electron probe micro analyser (EPMA, Shimadzu EPM810Q). Accel voltage, specimen current and beam diameter were 15KV, 10nA and 5 μm respectively. The amount of inorganic impurities in ink was determined by an inductively coupled plasma emission spectrometer (ICP, Seiko Instruments & Electric LTD.).

Results and Discussion

Inorganic and Organic Koga

Table I shows representative elemental composition of koga caused by inks composed of various dyes and solvents. Iron, silicon and other inorganic elements were detected in addition to carbon in the case of ink I and II, while only carbon was detected in the case of ink III and IV. We will call the koga including inorganic elements as "inorganic koga", and the koga with carbon alone as "organic koga". Organic koga is caused by dystuffs[1].

Table I. Elemental Composition of Koga

	Atomic%				
Ink	C	Fe	Si	Sn	Cr
I	33	17	33	17	—
II	18	30	13	4	9
III	100	—	—	—	—
IV	100	—	—	—	—

Inorganic Impurities in Ink

Source materials of inorganic koga are considered to be inorganic impurities in ink[1]. Inorganic elements in ink were analyzed by ICP. Figure 2 shows amount of

iron in ink and koga. The amount of iron in ink correlates with that in koga. Figure 3 shows amount of silicon in ink and koga, also indicates correlation between silicon in koga and in ink. The correlation suggests that iron and silicon in ink cause kogation.

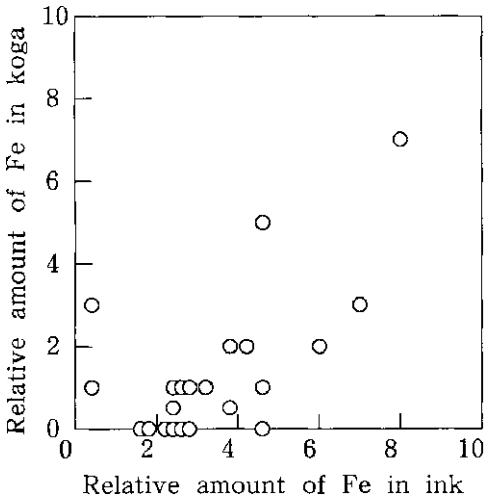

Figure 2. Fe in ink and koga

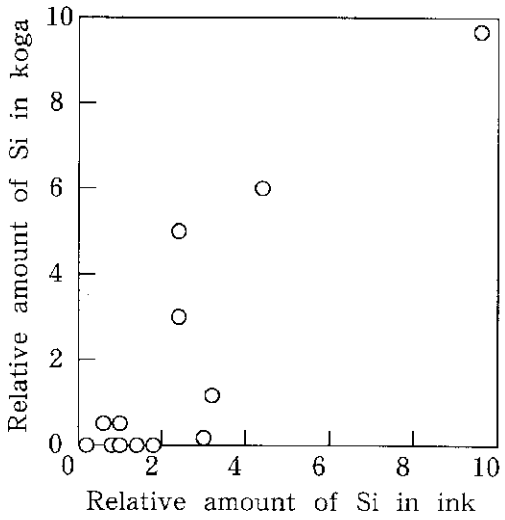

Figure 3. Si in ink and koga

Addition of Silicon to Kogation-free Ink

We artificially added silicate aqueous solution to kogation-free ink, and evaluation its kogation. Table II shows changes of kogation rank and amount of silicon in koga with a change of amount of silicon added. Kogation rank deteriorated with increasing amount of silicon added. Furthermore, amount of silicon in koga increased correspondingly to amount of silicon added.

Removal of Inorganic Impurities from Ink

The analytical results and addition experiments indicate that inorganic impurities in ink cause kogation. To confirm this, we removed inorganic impurities from ink which cause kogation and evaluated its kogation. Kogation rank was improved drastically in impurities-free ink.

We also found that masking of inorganic impurities by chelating agent was effective to improve kogation.

Table II. Addition of Si to Kogation-free Ink

Relative amount of Si added	Kogation rank*	Relative intensity of Si in koga by EPMA
0	A	0
1	Bo	1.0
2	B	1.9
30	B	2.0
50	C	4.8

* A (Non) <Bo <B<C (Medium)

Conclusion

1. Iron, silicon and other inorganic elements were detected in koga and ink.
2. Addition of silicon to kogation-free ink deteriorates kogation.
3. Removal or masking of inorganic impurities improve kogation.

Acknowledgment

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References

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