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Development of the new thermal inkjet head on SOI wafer

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Abstract

A new thermal inkjet printer head on SOI wafer was proposed. It was composed of two rectangular heaters with same size. So we could call it T-jet (Twin jet). As it uses the back shooting mechanism, the ejected ink's direction is the opposite direction of the bubble generated. T-jet has a lot of merits. It has the advantage of being fabricated with one wafer and is easy to change the size of chamber, nozzle, restrictor and so on because of being manufactured on SOI wafer. The chamber was formed in its upper silicon whose thickness was 40 μm. The chamber's bottom layer was silicon dioxide of SOI wafer and two heaters were located underneath the chamber's ceiling. And the restrictor was made beside the chamber. Nozzle was molded by process of Ni plating. Ni was 30-μm thick. Nozzle ejection test was performed by printer head having 56 nozzles in two columns with 600 nozzle per inch and black ink. It was measured a drop velocity of 12 m/s, a drop volume of 30 pl, and a maximum firing frequency of 12 kHz for single nozzle ejection. Throwing out the ink drop in whole nozzles at the same time, it was observed that the uniformity of the drop velocity and volume was less than 4%.

Keywords: Inkjet head; Printer; MEMS

1. Introduction

Lately, the various components have been fabricated by the MEMS technology. As the MEMS technology uses the semicon technology, it is easy to make the small actuators and components on a massive scale. Currently, it is the general technology that is used to manufacture the samples in the inkjet head, display, sensors, bio, optical pick-up part. Particularly, the inkjet head part is the production and marketing actually.

Inkjet head is the core component in inkjet printer and it makes the ink drop ejected from nozzle. The heater using method is widely known as the method that heater makes the bubble which makes the ink drive out.

Generally, if we split the branch of the ejection method, the roof shooting [1,2], which means the

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ejection in the same direction of the firing and creating, there are the side shooting [3,4] which means the ejecting in the side direction of them, and the back shooting [5–8] which means the opposite direction of them.

The thermal type inkjet head using the heater is composed of the nozzle which makes the ink drop throw out, the chamber where the heater makes the bubble, the restrictor which is the ink path from manifold to chamber and the manifold which is the way from the cartridge. Although the various factors have influence on the performance of the head, we can say the main factors are heater's power and the fluidic resistance at the nozzle and the restrictor.

The ink ejection cycle is drawn as the next. First, the heater makes the bubble. It causes the force and the ink is ejected from the nozzle by it. After the bubble was expired, the ink flows from restrictor to chamber.

2. Design

The structure in the new inkjet head is shown in Fig. 1. The chamber's height is 40 μm and the heaters are located underneath the chamber's ceiling. They are two same size rectangular heaters and are composed of TaAl. The passivation layer is constituted around the heaters in order to protect them and to raise the thermal efficiency. The thermal dissipation makes the heaters connect to the Si substrate to discharge the generated heat. The

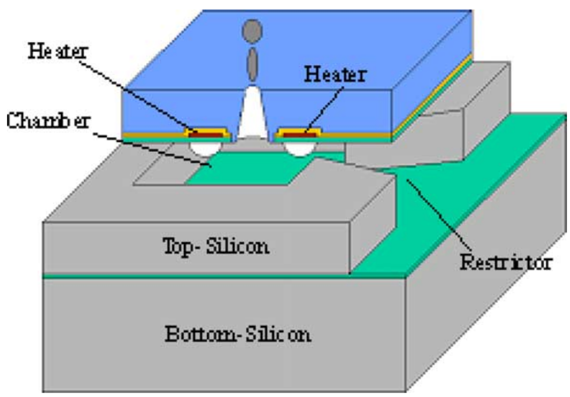

Fig. 1. Schematic of the proposed print head.

nozzle is the shape of the taper. It is the reason that the taper nozzle gives the high velocity of the drop while the ejection.

3. Fabrication

3.1. Fabrication process

In order to manufacture the device we used the SOI wafer with MEMS technology. First, we made the trench at the upper Si with the Si deep reactive ion etching (DRIE) process, as shown in Fig. 2(a). After that, we filled the oxide in the trench with oxidation process, as shown in Fig. 2(b). Next time, the wafer was planarized with CMP process, as shown in Fig. 2(c). This process was the step where the chamber and the restrictor were formed. In the final step they would be made through XeF_2 etching. After organizing the side wall, we deposited the silicon nitride and silicon oxide with LPCVD in the upper side as shown in Fig. 2(d). They were the ceiling of the chamber and restrictor. After that, we deposited the heater and electrode and pattern them, as shown in Fig. 2(e). After we had deposited the aluminum, we patterned it to make the thermal plug through which heat could go out as shown Fig. 2(f). Making the mold with the photoresist as shown in Fig. 2(g), we formed the nozzle with the process of the electroplating. At this time the copper was put to the seed. After formation of the nozzle the manufactured PR mold was removed by acetone, as shown in Fig. 2(h).

After the topside process as this, we dig the silicon with TMAH to form the manifold, as shown in Fig. 2(i). Finally, we coated the inside of the chamber with the parylene and made the chamber through etching silicon with XeF_2, as shown in Fig. 2(j). After that the parylene was removed with O_2 plasma ashing.

3.2. Trench filling process

The reason of using the SOI wafer to manufacture the T-jet was that it was easy to define the chamber's shape with silicon dioxide in advance. After digging the trench at the required size and location we filled the silicon dioxide in it. After