

MEMS Fabrication & Design HW#3

Question)

1. Find technical papers (HP printer head).
2. Take apart old printer head and take some pictures.
3. See if you can identify MEMS parts.

Answer)

1. HP inkjet printer head

- Introduction

fabrication and characterization of a thermal ink jet (TIJ) printhead suitable for high speed and high-quality printing. The printhead has been fabricated by dicing the bonded wafer, which consists of a bubble generating heater plate and a Si channel plate. The Si channel plate consists of an ink chamber and an ink inlet formed by KOH etching, and a nozzle formed by inductively couple plasma reactive ion etching (ICP RIE). The nozzle formed by RIE has squeezed structures, which contribute to high-energy efficiency of drop ejector and, therefore, successful ejection of small ink drop. The nozzle also has a dome-like structure called channel pit, which contributes to high jetting frequency and high-energy efficiency. These two wafers are directly bonded using electrostatic bonding of full-cured polyimide to Si. The adhesive-less bonding provided an ideal shaped small nozzle orifice. Use of the same material (Si substrate) in heater plate and channel plate enables the fabrication of high precision long printhead because no displacement and delamination occur, which are caused by the difference in thermal expansion coefficient between the plates. With these technologies, we have fabricated a 1" long printhead with 832 nozzles having 800 dots per inch (dpi) resolution and a 4 pl. ink drop volume.

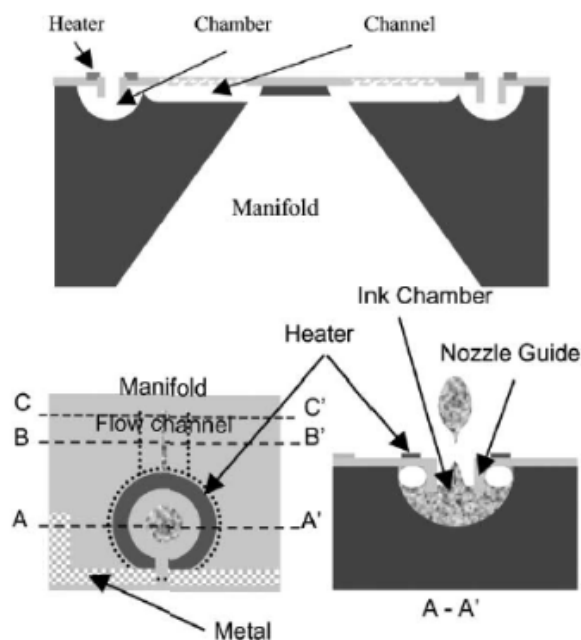


Fig. 1. Schematic view of DomeJet.

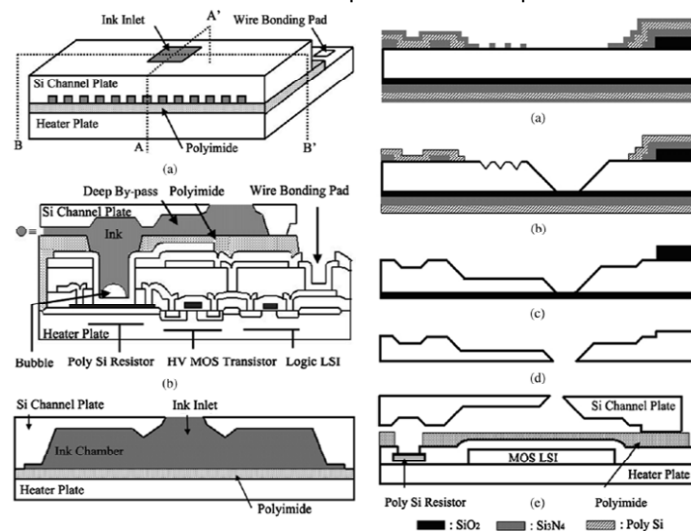
- Fabrication

1) heater plate

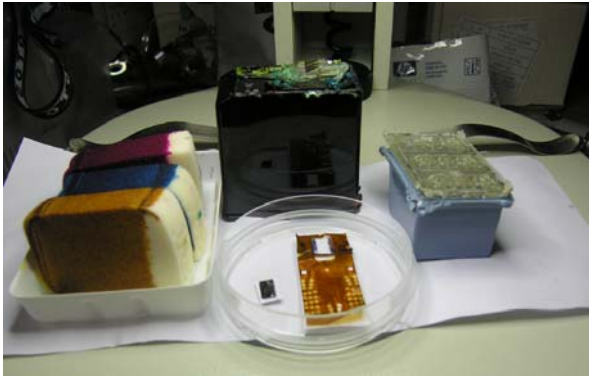
The heater plate consists of logic MOS LSI, embedded high voltage (HV) MOS transistor, Poly Si heating resistor and polyimide film, which protects the device from ink attack. The polyimide film is patterned by O plasma RIE. The process steps are (a) The polyimide is coated and cured at temperature (350 C) above the glass-transition temperature (285 C) to enhance the durability against ink. (b) The polyimide film is planarized by chemical mechanical polishing (CMP). (c) The polyimide film is patterned by O plasma RIE by using a mask of Si-containing resist. The polyimide used was Durimide 7520 polyimide from Arch Chemicals Inc. having a final thickness of 10 m.

2) Si channel plate

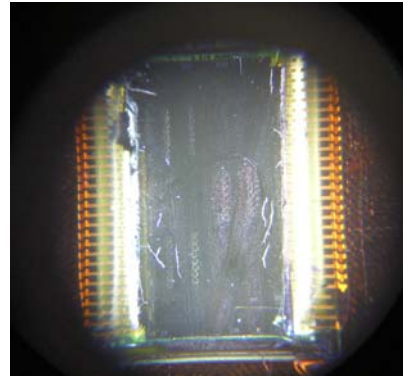
Si channel plate consists of ink inlet and ink chamber formed by KOH etching and nozzles formed by ICP RIE. The ink inlet is a through-hole structure to supply ink from the ink tank to the ink chamber. The ink chamber is connected to each nozzle. The fabrication process is shown in Fig. 3. The figure corresponds to cross section of Fig. 2(a). The process consists of 2-step KOH etching and 1-step ICP RIE. The process steps are as follows. (a) All the etching mask layers are formed by thermal SiO film, LPCVD Poly Si film or LPCVD Si N film. The process requires four mask layers. (b) The first KOH etching is performed, followed by the removal of the first Si N film using H PO solution. Here, the Poly Si film represented on top of the wafer serves to protect the second Si N film from the H PO solution. In this step, the ink inlet (through-hole structure in the Si substrate) is formed. (c) The second KOH etching is performed, followed by the removal of the second Si N film using H PO solution. In this step, the channel pit and the deep bypass are formed. The deep bypass is for connecting the ink chamber and channel as shown in Fig. 2(b). To form the deep bypass, the triangular sacrificial pattern represented in Fig. 3(b) is used. (d) The Si substrate is etched using an ICP RIE, followed by the removal of the SiO film using HF solution. The shape of nozzle orifice is rectangular because of anisotropic etching. And the depth of the ICP RIE corresponds to the height of the nozzle orifice. In this step, the Si channel plate is completed. (e) The Si channel plate wafer is bonded to the completed heater plate wafer.



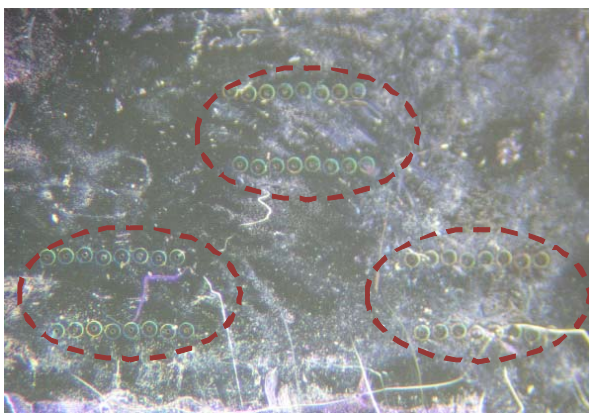
2. Picture of the HP printer head



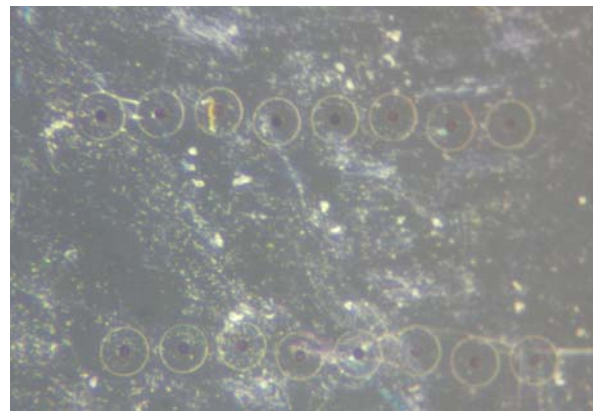
Printer Head Separation



Si Channel Plate



Nozzles for Three Color Inks



Magnified view of Nozzle

3. MEMS Part



Channel for Yellow

Channel for Blue

Channel for Red