Design and test UHV printer for writing electrode

field metal method

Yiwei Xu

State Key Laboratory for Surface Physics

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1. previous work
2. current work
3. future work
4. summary

1 previous work
- achievement
- difficulties
- solutions

2 current work

3 future work

4 summary

1 previous work
achievement
difficulties
solutions
2 current work
3 future work
4 summary

achievement

- A simple displacement table was built.

achievement

- A simple displacement table was built.
- Successfully draw the line in the air.

1 previous work
- achievement
- difficulties
- solutions

2 current work

3 future work

4 summary

difficulties

- Can't draw any lines on the glove box

1 previous work
- achievement
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4 summary

solutions

- Change the gallium indium alloy:

solutions

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  1. Field's metal

solutions

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  2. Metallic particles(Cu Ag)

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  3. GIS

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  4. Inorganic

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- Improved adhesion of silicon wafers:

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- Improved adhesion of silicon wafers:
  1. Temperature gradient

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  3. PMA

1 previous work

2 current work
NUS article
our work

3 future work

4 summary

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4 summary

tension driven printing

printing system

- The four-axis micro-positioning stage (PRO165LM, Aerotech) was driven by software (Ensemble, Aerotech).

tension driven printing

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- A 5 ml stainless steel syringe (SSY-5E, Musashi Engineering) (ink barrel) with a Luer lock type was installed inside the heater.

tension driven printing

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- The resistance bulb-type temperature control block (TB-5E-K, Musashi Engineering) (heater) was mounted on the platform of the micro-positioning stage, whose temperature was controlled by the resistance bulb temperature controller (TCU-02, Musashi Engineering).
- A 5 ml stainless steel syringe (SSY-5E, Musashi Engineering) (ink barrel) with a Luer lock type was installed inside the heater.
- A double-thread screwed plastic nozzle with IDs of 210, 230 or 260 m (Musashi Engineering) was mounted on the syringe.

tension driven printing

printing process

- clean the sample surface(to enhance adhesion,we can use some physical treament ,but it is impossible in our case)

tension driven printing

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tension driven printing

printing process

- clean the sample surface(to enhance adhesion,we can use some physical treament ,but it is impossible in our case)
- Around 10 g Field’ s metal was loaded into the ink barrel with a mounted nozzle
- Then, the ink barrel was pre-heated at the target temperature (80-100 $^{\circ}C$) in the heater for half an hour to melt the Field’ s metal

tension driven printing

printing process

- To wet the new nozzle, the initiation step was conducted by pressing down the syringe head cap, which was removed after initiation, to extrude several drops of molten metal through the nozzle

tension driven printing

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- Next, the nozzle tip was brought in close proximity to the substrate, where the distance between the nozzle tip and substrate is 100 μm

tension driven printing

printing process

- To wet the new nozzle, the initiation step was conducted by pressing down the syringe head cap, which was removed after initiation, to extrude several drops of molten metal through the nozzle
- Next, the nozzle tip was brought in close proximity to the substrate, where the distance between the nozzle tip and substrate is 100 μm
- Then, the 2D and 3D printing processes were carried out by the micro-positioning stage according to the predesign.

tension driven printing

printing parameters

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tension driven printing

printing parameters

- temperature: 80-100 $^{\circ}C$(and as the temperature increases, the width of line increases)
- nozzle ids: 210, 230 or 260 μm(in this interval the id increases, the width of line increases,and width of the line is close to the id)
- printing speed:10-20 mm/s(when the speed increases, the width of line decreases,and the speed can't exceeed 100 mm/s)

tension driven printing

some problems need to be solved

- how to reach the width requirement of the electrode

tension driven printing

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- how to reach the width requirement of the electrode
- how to finish the initiation process in the equiqment
- how to limit the volume of the system
- how to refill the metal in uhv environment

tension driven printing

- These problems are important,but we don't consider them in this stage

tension driven printing

- These problems are important,but we don't consider them in this stage
- because we have much more problems.

1 previous work

2 current work
- NUS article
- our work

3 future work

4 summary

our current work

because the printing system in NUS article is unreachable in one month ,we need to build many things by ourselves

- first of all ,we need a metal syringe(as the field metal's molt point is higher than the material used before,and need to be heated uniformly).We build it using an Air duct and a metal nozzle.

图 1: metal syringe

our current work

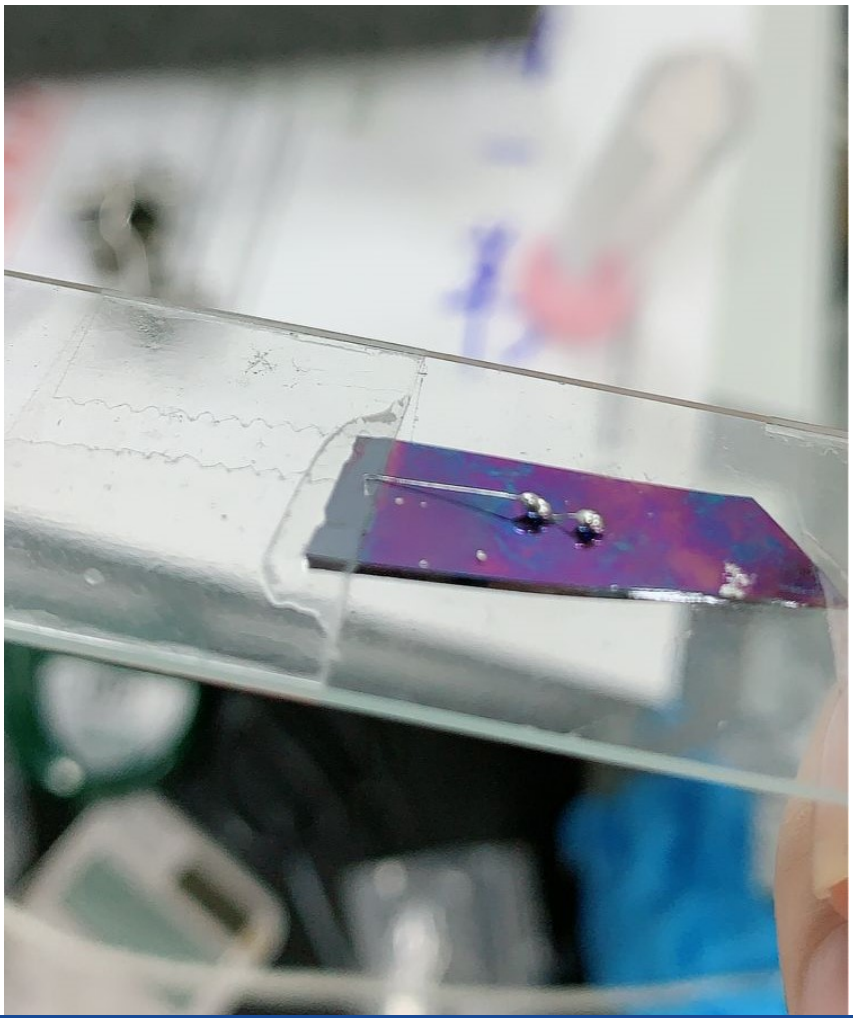
And to heat the system uniformly,we conside to use Electromagnetic induction heater,and it hasn't arrived yet.

图 2: turblance heater

our current work

At the same time ,we try to draw line in the air.

- This is the line drawn in the air by hand.



our current work

At the same time ,we try to draw line in the air.

- This is the line drawn in the air by the displacement table using program written by MTGroup.

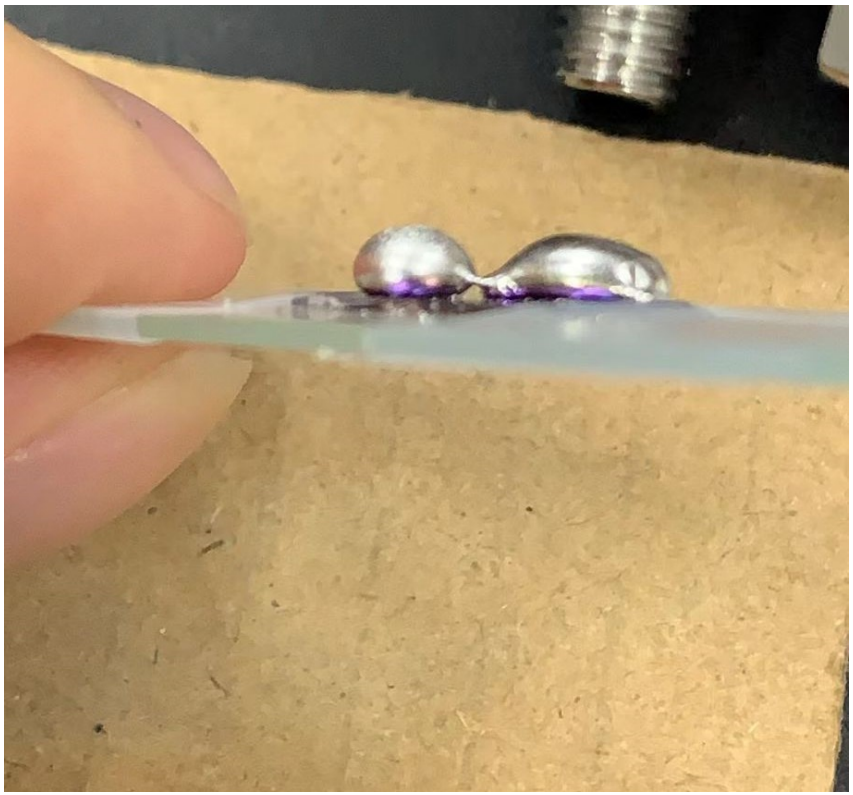


图 4: line in the air by displacement table

our current work

the displacement table is too slow to reach the required speed ,so there is obvious liquid drop.And the diplacement is small ,so only the middle part of the line is thin enough,much liquid metal dropped after the table stopped,making the line thicker.And we think the time between we apply pressure and move the table need further study.

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4 summary

general ideas

- repeat the experiement in glove box

general ideas

- repeat the experiement in glove box
- repeat the experiement in uhv

general ideas

- repeat the experiement in glove box
- repeat the experiement in uhv
- design the system in uhv and find the suitable parameters

detailed ideas

- At that time ,we transport some of our equipment into the glove box,and we master the pressure controller using labview program.

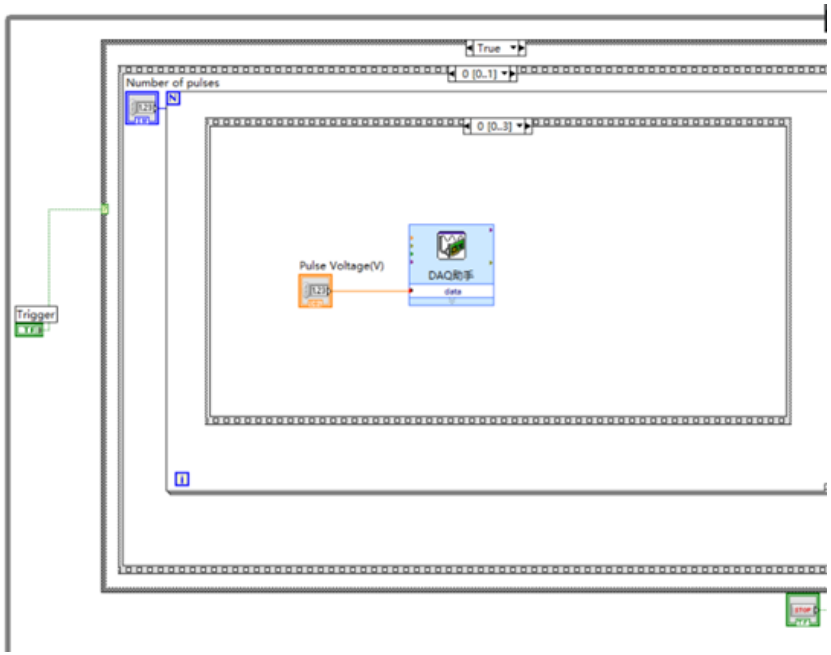

图 5: labview

detailed ideas

- I decide to apply a pluse pressure to complete the initiation process.

detailed ideas

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- and draw the line by hand because the displacement table is too big to place in the glove box.

detailed ideas

- I decide to apply a pluse pressure to complete the initiation process.
- and draw the line by hand because the displacement table is too big to place in the glove box.
- And if it doesn't work,we will try to use other methods to enhance the adhesion of the field metal and silicon substrate.

1 previous work

2 current work

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4 summary

current progress

- learnt some software including labview 、MTGroup's program and solidworks

current progress

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- build syringe and heater

current progress

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- draw line in the air

current progress

- learnt some software including labview 、MTGroup's program and solidworks
- build syringe and heater
- draw line in the air
- master the pressure controller in glove box

reference I

Thanks!