Development of Large Size Ion Source for Ion Shower Doping

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abstract

This time, we introduce Ion shower doping system (ISD system) which is one of plasma application equipment. ISD system is a non mass-separation type large beam size ion implantor for manufacturing thin film transistor in Liquid Crystal Display (LCD) .

We noticed features of backet type ion source that are capability for large beam size, beam uniformity in large beam area , and wide range controlability for beam current density. Then we started development of the ion source for ISD system as one of industrial applications of backet type ion source.

Most impressive feature of our ion source is controlability of very low current density beam.

ISD system

Fig.1,2 show schematic diagram of our Ion Shower Doping System and Ion source for ISD system. This system is a one of production equipment for liquid crystal display. And, purpose of this systems is P,B doping for thin film Si formed on glass substrate. In the case of ISD system, source gases for P,B Ion beam generation are H2 Dilute PH3, B2H6 gas. ISD is a impurity doping technique without mass separation and beam scanning.

We propose to use this doping technique for 3-type doping process , Source/Drain, LDD, Channel doping. Fig.3 shows these 3-type application. For these application we must control dose quantity over 3-order.

So, low current density controlability of our ion source is a impressive feature for ISD technique.

performance of ion source

Performance of our ion source is as below.

Beam current density :0.05～15 μ A/cm2
Beam acceleration voltage:10～100keV
Source gas : PH3/H2, B2H6/H2
Plasma chamber inner diameter
: φ 1000 mm (typical system)
Extraction beam size
: □600 mm (typical system)
Beam uniformity ≦ ± 5 %

Fig.3,4 show typical beam uniformity of our ion source. They show we can get enough beam uniformity for wide range of beam current density.

Fig.6 shows we can control 10^{11}/cm2 order dose quantity by using 0.1% dilute source gas. So, we consider our system and approach is suitable for impurity doping of thin film transistor fabrication process for LCD.

Fig.7 shows new concept system which are under developing.

Conclusion

Ⅰ. Performance of our Ion Shower Doping System can be enough to fabricate S/D and LDD region.

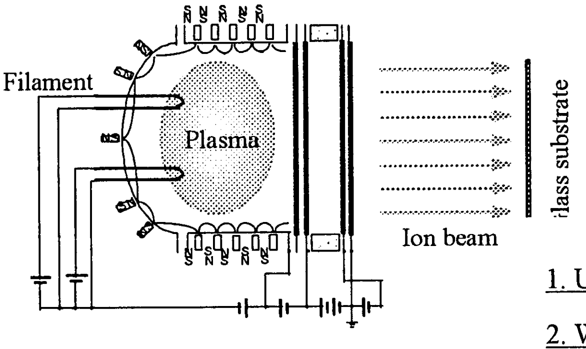
Ⅱ. We propose to adopt to channel doping using gas dilution control. Using 0.1% diluted source gas and 0.05 μ A/cm2 ion beam , our system will produce high cost performance to fabricate from S/D region to channel region.

Ⅲ. Now we are developing new concept system to adopt over 600x720 substrate.

FIG.1 Ion Shower Doping System

Ion Doping Technique.

Impurity doping technique for making TFT.



1. Using large size ion beam.
2. Without mass separation.
3. Without beam scanning.

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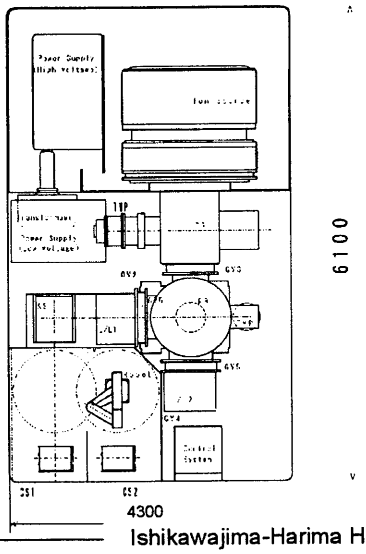
Fig.2 Ion Shower Doping System (Production Model)



Main specification

Substrate Size : 400 x 500

Throughput : 50 sheets/hr (32s doping)

Beam Acc. Voltage : 5kV to 100kV

Current density : 0.05uA/cm^2 to 15uA/cm^2

Beam uniformity : < ±5%

Ion Source (filament) life time : > 700hr

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Fig.3 Beam Uniformity

90kV,5.0uA/cm^2, ±3.8%

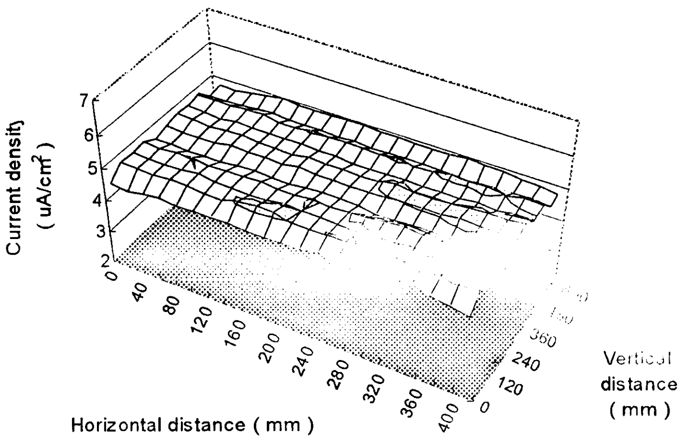

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Fig.4 Beam Uniformity

90kV,0.05uA/cm^2, ±4.9%

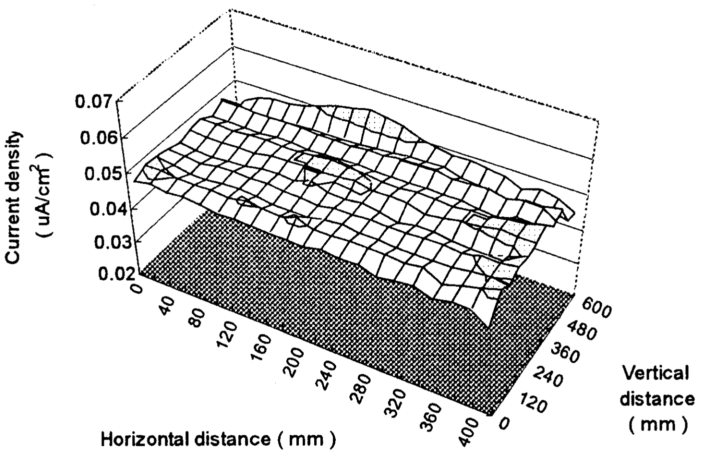

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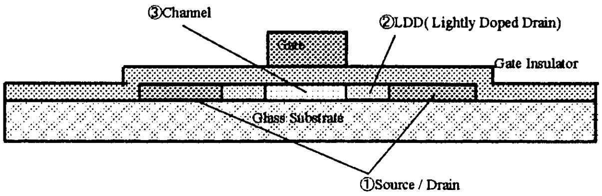
Fig.5 Doping Performance



Region	Total Dose	Gas	Current Density	Doping Time
① Source/Drain	1E15-5E15/cm²	5% $PH_3(B_2H_6)/H_2$	10uA/cm²	16s - 80s
② LDD	1E12-1E13/cm²	5% $PH_3(B_2H_6)/H_2$	0.05uA/cm²	3.2s - 32.0s
③ Channel	5E11-1E12/cm²	0.5% B_2H_6/H_2	0.05uA/cm²	3.2s - 32.0s

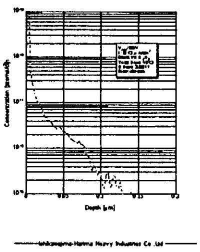
Doping Time < 10s is too short.

Fig.6 Proposal for Channel Doping.

Control of Gas Dilution Ratio

Using 0.1% B_2H_6/H_2 source gas

Current Density	Total Dose	Boron Dose	Doping Time
0.13uA/cm^{-2}	1.0E13 cm^{-2}	3.0E11 cm^{-2}	12.3s

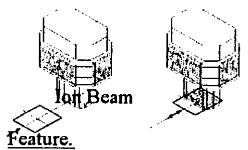


Advantage of Gas Dilution Control

(1) Using same doping technology from S/D region to Channel region.

(2) Higher cost performance than introducing an ion implanter for channel doping..

Fig.7 New Concept for Huge Substrate.



Feature.

Substrate is irradiate with mechanical scanning.

Ion source fully covers the short side of substrate.

Current density is kept lower than very narrow ion beam like implanter.

Advantage.

Huge substrate (over 600 x 720) is able to be handled.

Fast tact time is available. (comparison with implanter.)

Damage induced by ion beam can be reduced. (comparison with implanter.)