A new form of impurity cluster in casting quasi-single crystalline silicon

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Background

➢ Application of large size thermal field in casting quasi-single crystalline silicon

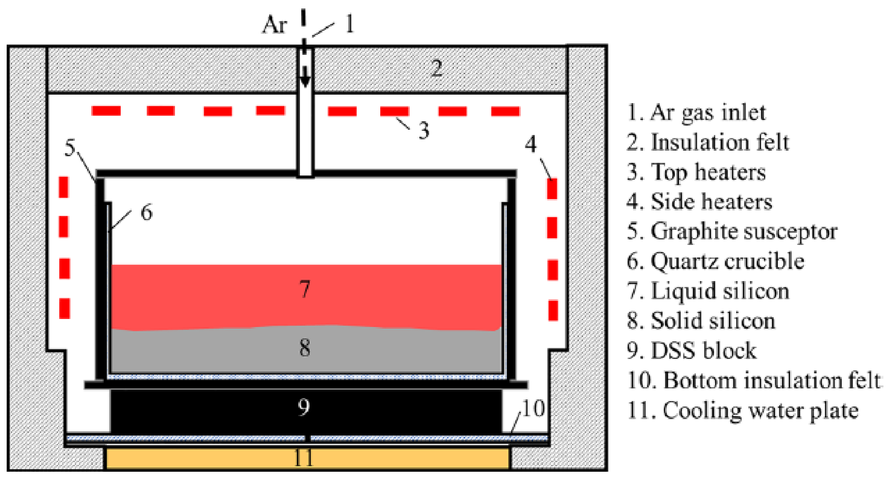

Fig. 1. Schematic diagram of the furnace with large size thermal field.

➢ Research purpose

- A new type of "black spot" impurity in casting quasi-single crystalline silicon was solved by thermal field optimization.

Research contents

➢ Expression of black spot impurity in silicon ingot

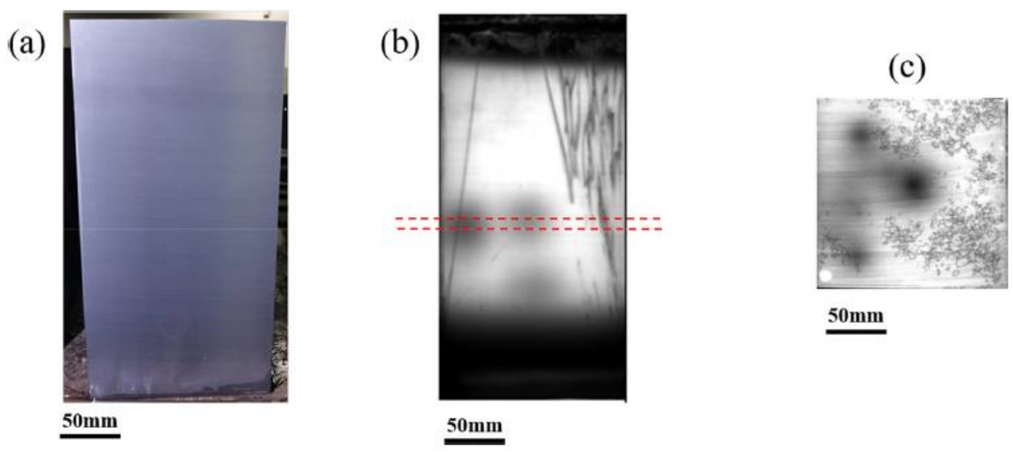

Fig. 2. (a) Side view of the silicon block. (b) PL image of the silicon block.

(c) PL diagram of the section specimen, the dashed lines in (b) represent the cutting positions.

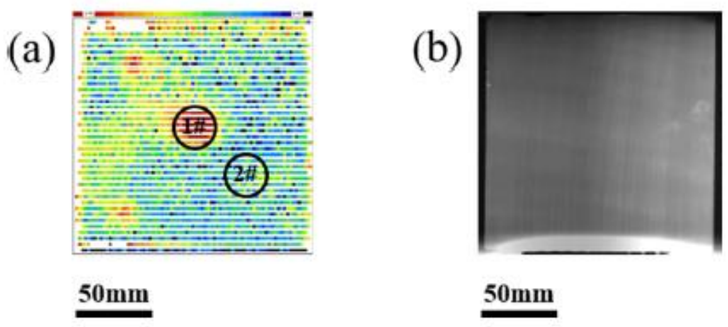

Fig. 3. (a) Minority carrier lifetime distribution black spot sample.
(b) IR detection diagram of the sample to show the micron agglomerate solids.

Result analysis

➢ Thermal fluid velocity distribution after thermal field optimization

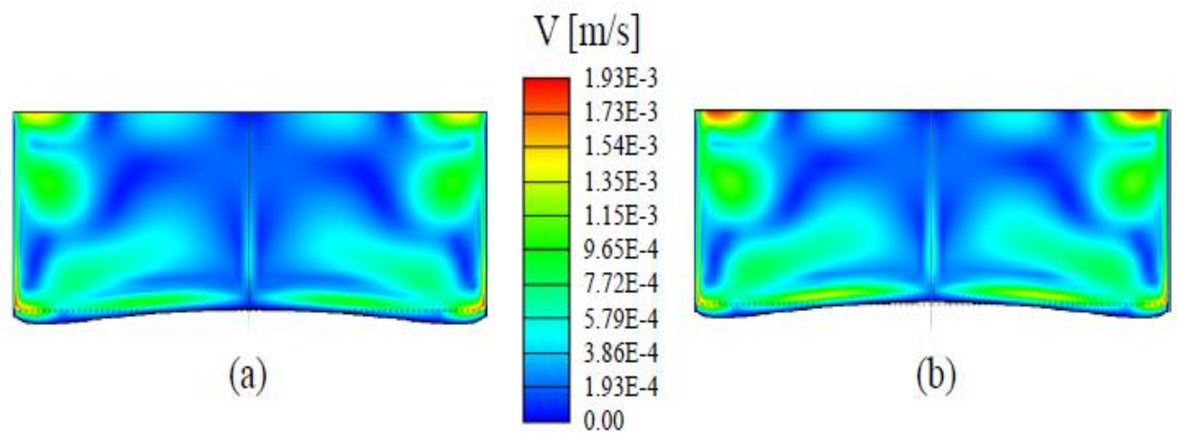

Fig. 4. Comparison of fluid field before and after optimization.

- The melt fluidity was weak before optimization.
- Melt fluidity was enhanced after optimization.

➢ Improvement effect of silicon ingot after thermal field optimization

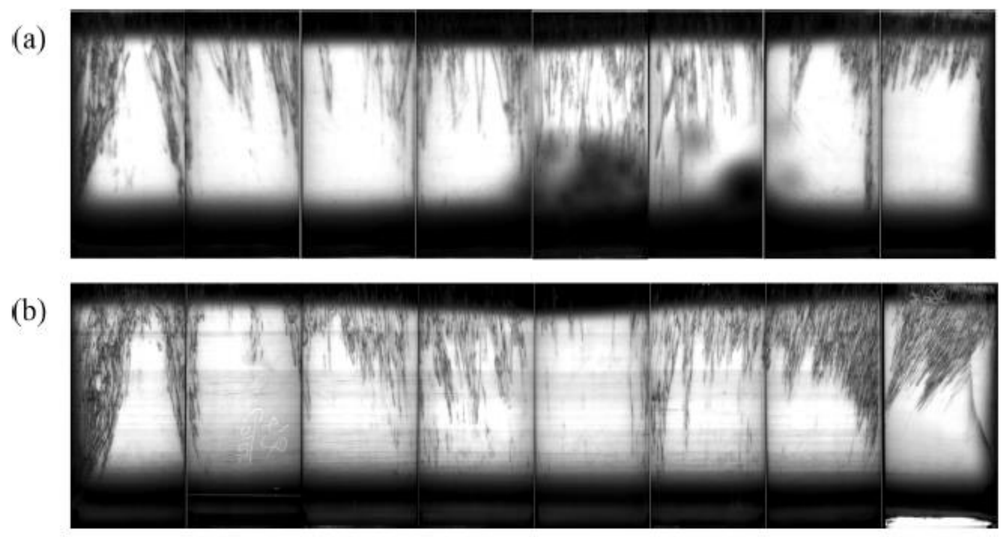

Fig. 5. PL test images of the crystal before (a) and after (b) the optimization of side heater position.

- There is no "black spot" at the same position of the crystal obtained after optimization.

Conclusions

1. The "black spot" cluster is not agglomerate solids. But is composed of conventional metal impurities such as iron, aluminum, nickel, etc.
2. When the S/L interface is more convex, the melt flow is more strong which drives the impurities to disperse in the melt and thus avoid the formation of the "black spot" in the crystal. There should be a balance between the convexity of the interface and thermal stress or dislocation defect density.