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# Supporting Information

*Article*

# Study of flow pattern defects and oxidation induced stacking faults in Czochralski single-crystal silicon growth

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**Citation:** Yen, C.-C.; Singh, A.K.; Chung, Y.-M.; Chou, H.-Y.; Wuu, D.-S. Study of Flow Pattern Defects and Oxidation Induced Stacking Faults in Czochralski Single-Crystal Silicon Growth. *Crystals* **2023**, *13*, 336. https://doi.org/10.3390/cryst13020336

Academic Editors: Sławomir Grabowski and Evgeniy N. Mokhov

Received: 4 January 2023
Revised: 6 February 2023
Accepted: 14 February 2023
Published: 16 February 2023

**Abbreviation**

1. interstitial oxygen ($O_i$)
2. Czochralski single-crystal silicon (CZ-Si)
3. flow pattern defects (FPDs)
4. oxidation induced stacking faults (OISFs)
5. pulling rate ($V$)
6. temperature gradient ($G$)
7. hydrofluoric acid (HF)
8. potassium dichromate ($K_2Cr_2O_7$)
9. optical microscope (OM)
10. microwave photoconductive decay ($\mu$-PCD)
11. Fourier-transform infrared spectroscopy (FTIR)
12. difference in oxygen concentration (delta $O_i$)

**Solution**

1. MAE1: consists of HF (49%), nitric acid ($HNO_3$, 49%), and acetic acid ($CH_3COOH$, 95%) in a volume ratio of 1:1:2.
2. SC1: is a mixture of 5% $H_2O_2$ and 1% $NH_4OH$.
3. MAE2: is prepared with a volume ratio of 1:1:3 for HF (49%), $HNO_3$ (49%), and $CH_3COOH$ (95%).
4. Secco: is a mixture of 49% HF and 0.15 M $K_2Cr_2O_7$ solution in a volume ratio of 2:1.

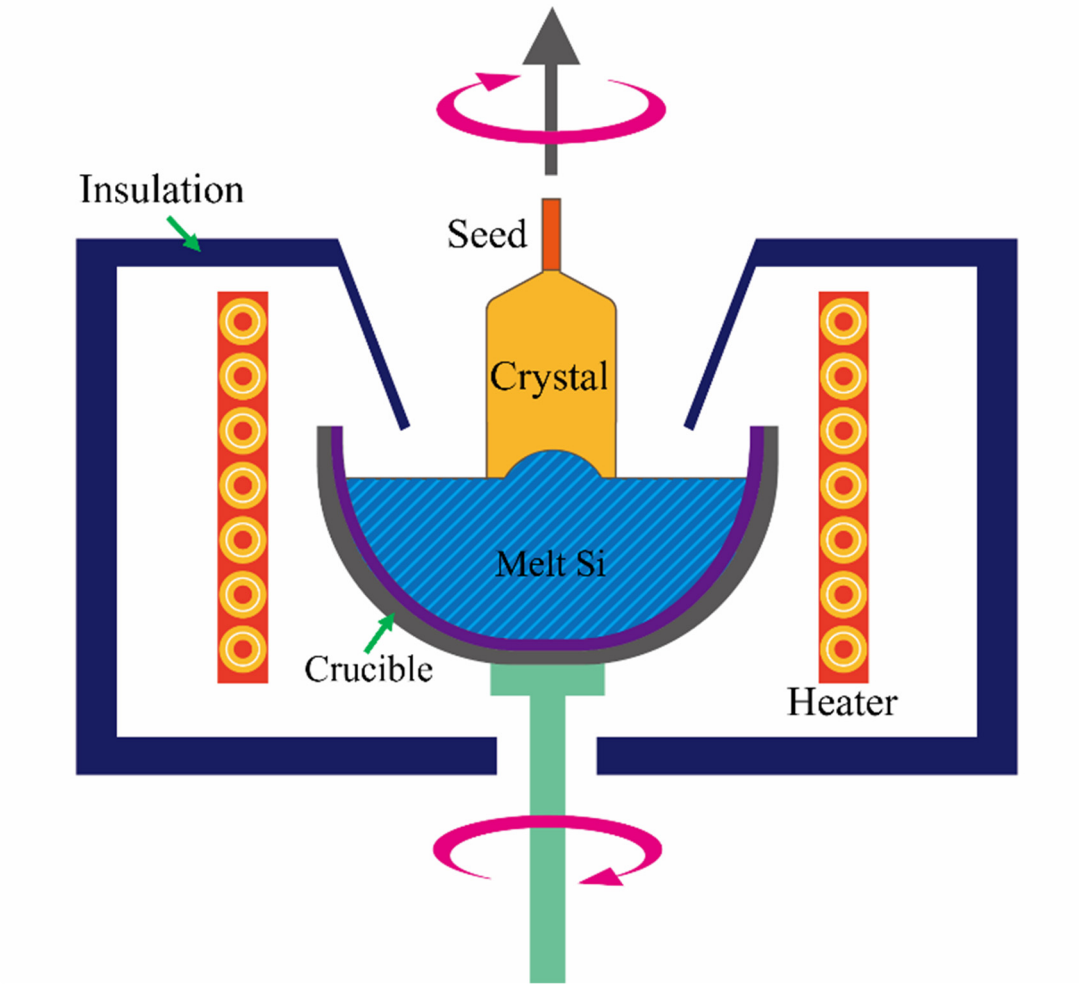


**Figure S1.** Schematic diagram of Czochralski furnace.

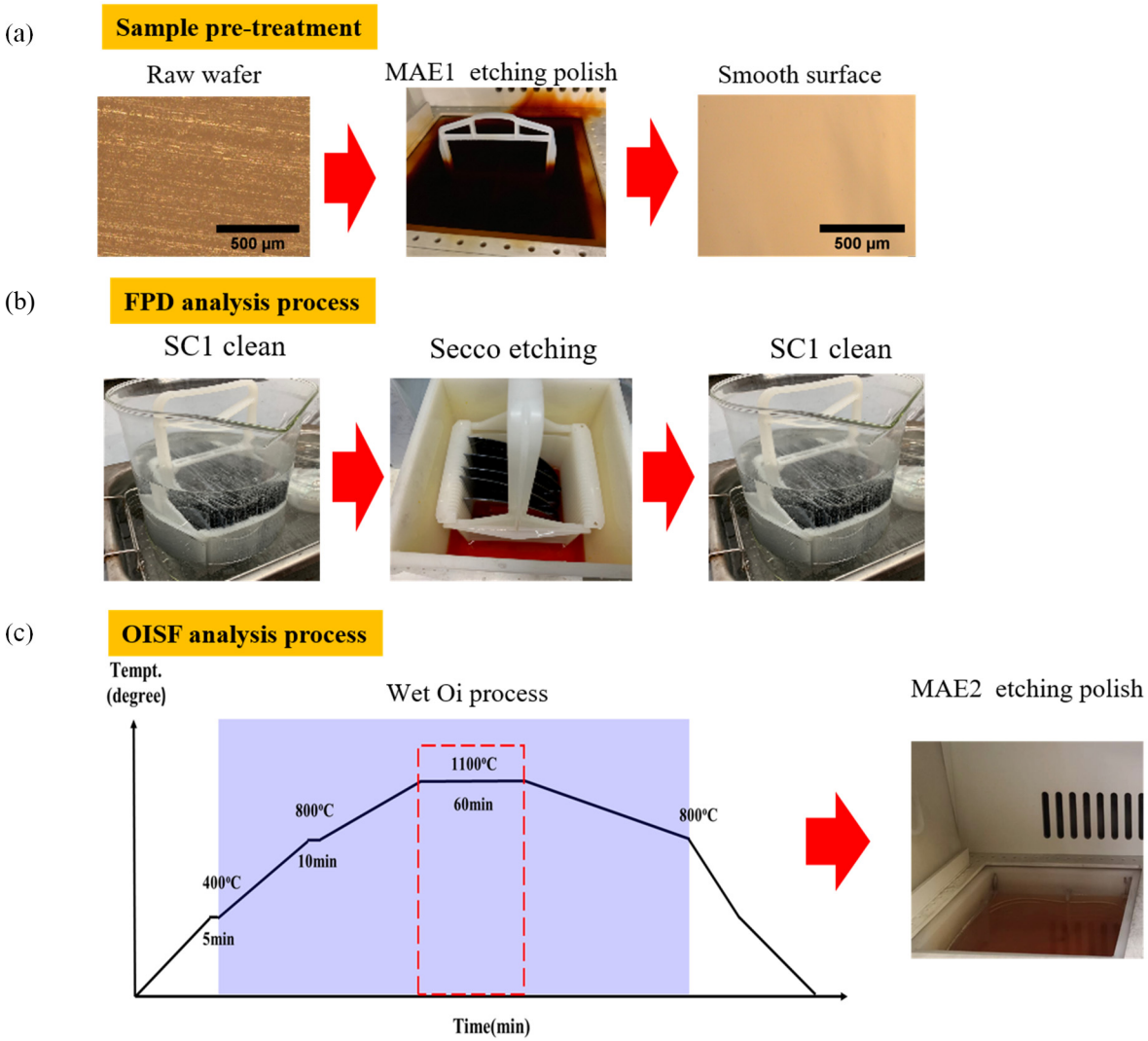


**Figure S2.** Flowchart of (a) sample pre-treatment, (b) pre-treatment for flow pattern defects (FPDs) analysis, and (c) pre-treatment for oxidation induced stacking faults (OISFs) analysis. The purple background indicates that the sample is under a high temperature wet oxidation.

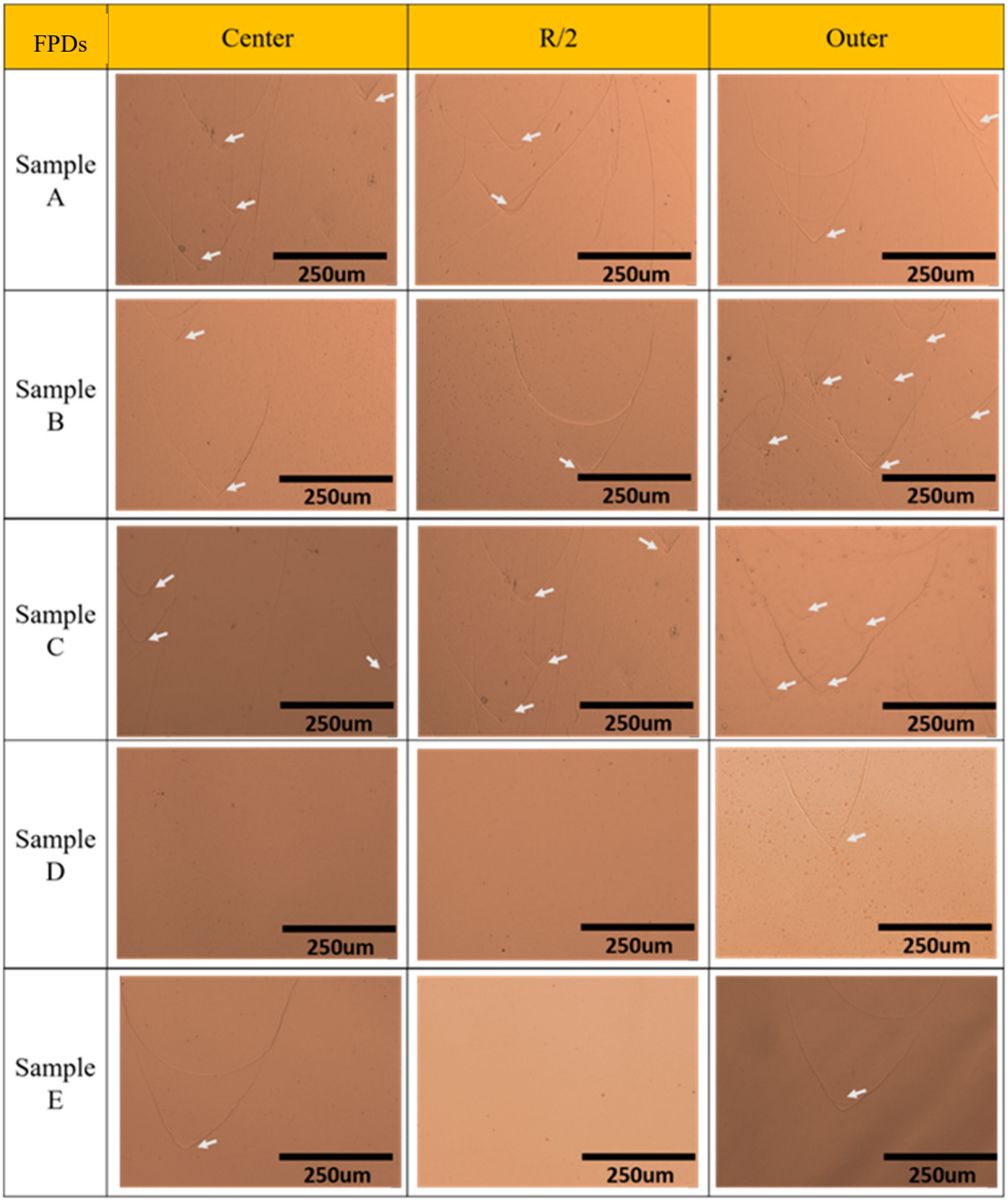


**Figure S3.** Optical microscope (OM) images for FPDs at the radial distribution after Secco etching. The Center, R/2, and Outer represent locations around 5 ± 5, 60 ± 5, and 120 ± 5 mm, respectively.

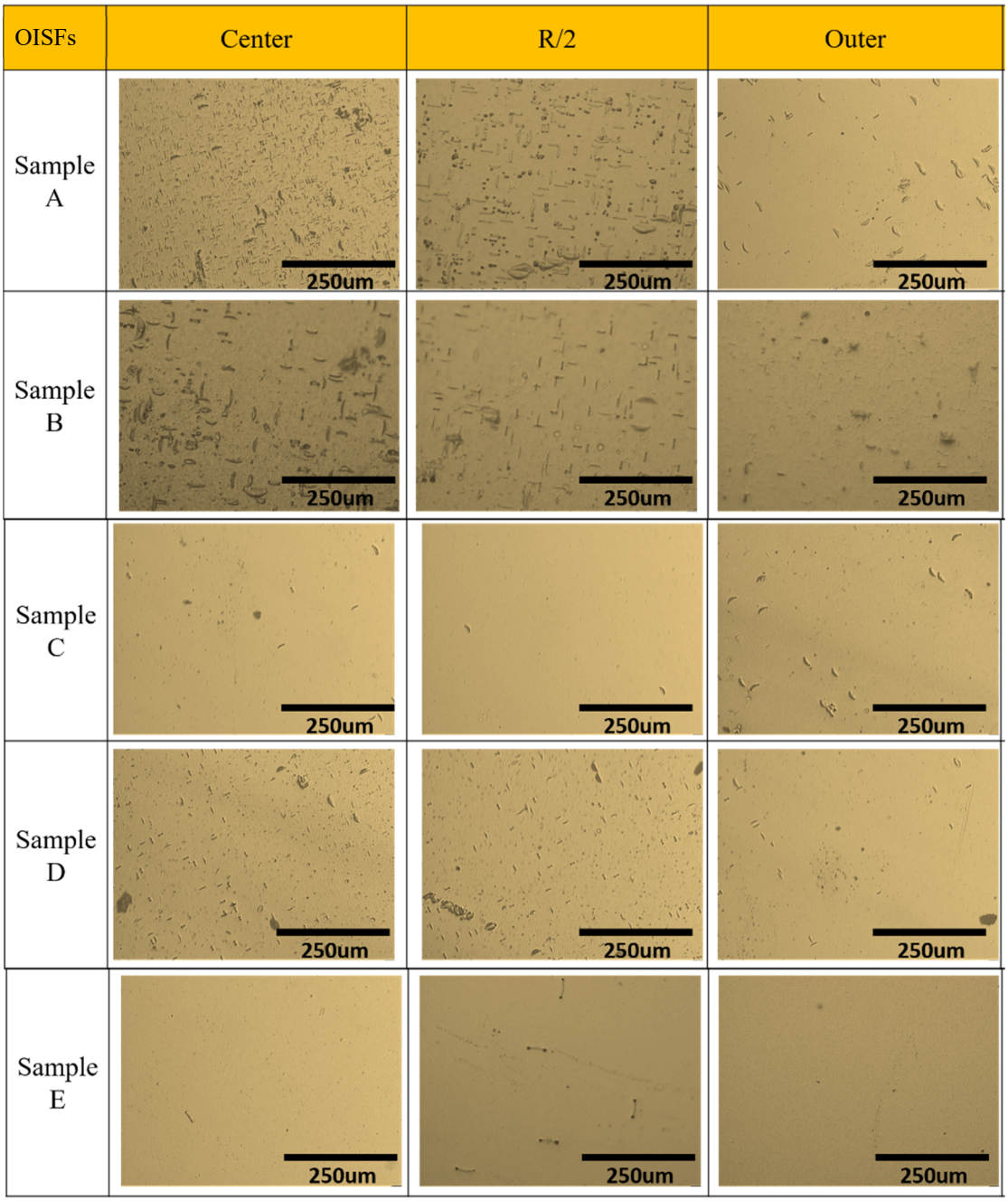


**Figure S4.** OM image for OISFs from the radial distribution after the high-temperature wet oxygen process and MAE2 etching. Center, R/2, and Outer represent locations around 5 ± 5, 60 ± 5, and 120 ± 5 mm, respectively.

**Table S1**. Parameters for a high temperature wet oxidation.

| Segment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Temp. (°C) | 400 | 400 | 800 | 800 | 1100 | 1100 | 800 | 400 |
| Time (min) | 45 | 5 | 50 | 10 | 60 | 60 | 100 | 30 |
| Dry oxygen | | | V | V | V | V | V | |
| Wet oxygen | | | | | | V | | |

V represents under the particular process.