Area: bulk crystal growth (Czochralski technique) of silicon

LARGE DIAMETE-RATIO CZOCHRALSKI SILICON CRYSTAL GROWTH TECHNIQUE USING "LIQUINERT" SILICA CRUCIBLES

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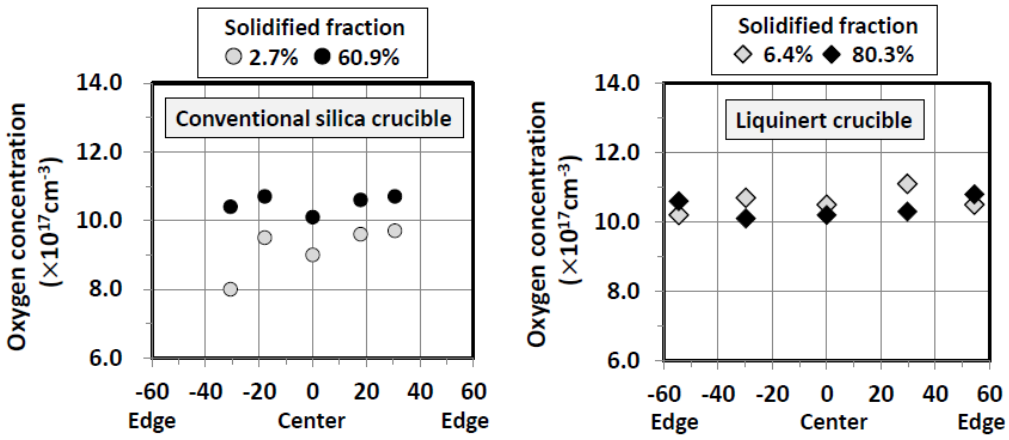
We have applied Czochralski (CZ) silicon growth technique to a large diameter-ratio growth technique (the ratio is defined as the diameter-ratio of growing crystal to crucible) using liquinert silica crucibles[1)]. For the solidification method in the melt, Kyropoulos technique[2)] has been known as a large diameter-ratio growth. Our new growth technique is on the progressive method of conventional CZ growth technique.

We prepared a small CZ puller with a silica crucible of 165 mm in diameter. We put 2.7 kg polycrystalline silicon into the crucible and grew several monocrystalline silicon crystals. The diameter-ratio was 0.35 - 0.42 for silicon grown from the melt in conventional silica crucibles and was 0.73 in liquinert crucibles. It was impossible to grow silicon of large diameter-ratios in conventional silica crucibles because the melt began to freeze from the crucible/melt interface toward the growing crystal.

Figure 1(a) and 1(b) show oxygen concentration of a 70 mm diameter silicon (diameter ratio: 0.42 = 70/165) and a 120 mm diameter silicon (diameter ratio: 0.73 = 120/165). We measured the oxygen content using FTIR method with the conversion coefficient of 3.14E17. For the large diameter-ratio silicon, we found more uniform distribution across the diameter and less segregation than for conventional silicon.



(a) (b)

Figure 1: Oxygen concentrations of (a) 70 mm diameter silicon and (b) 120 mm diameter silicon.

We think that the reason why the large diameter-ratio growth is possible is because the melt turbulence exists toward the crucible wall in liquinert crucibles, preventing the melt/crucible to freeze during the growth. On the contrary, the melt convection has been thought to be laminar flow near the crucible wall in conventional silica crucibles.

References

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2. C.-H. Chen, J.-C. Chen, C.-W. Lu, C.-M. Liu, J. Crystal Growth 318 (2011), pp. 162 - 167.