[0056] FIG. 5A is a cross-sectional view of simulated flowlines 109 and oxygen concentrations within melt 25 (with reference to FIG. 2) at an intermediate body growth stage, corresponding to growth of crystal 27 (with reference to FIG. 1) up to an intermediate ingot length of approximately 800 mm. At the intermediate body growth stage, depth 200 of melt 25 within crucible 10 is sufficiently deep to effectively decouple interactions between fluid motion induced by crystal flow cell 18 and buoyancy flow cell 17. A high seed rotation rate (i.e. 12 rpm) reduces the boundary layer thickness between melt line 36 and the gas above melt 25 to increase SiO evaporation. Further, a high seed rotation rate decreases melt flow from crucible 10 to crystal 27 by suppressing buoyancy flow cell 17 with induced crystal flow cell 18, as illustrated in FIG. 5A. Moreover, a high seed rotation rate creates an outward radial flow that retards the inward flow (i.e., transport) of SiO from crucible 10, reducing the oxygen concentration in crystal 27.

[0057] FIG. 5B is a cross-sectional view of simulated flowlines 109 and oxygen concentrations within melt 25 at a late body growth stage, corresponding to growth of crystal 27 from an intermediate ingot length of approximately 800 mm up to the total ingot length. Due to removal of melt 25 from crucible 10 associated with formation of crystal 27, depth 200 at the late body growth stage is shallower with respect to depth 200 at intermediate body growth stage as illustrated in FIG. 5A. At a similarly high seed rotation rate to that used to perform the simulation illustrated in FIG. 5A (i.e. 12 rpm), crystal flow cell 18 contacts the inner wall of crucible 10, causing convection of SiO formed at the inner wall of crucible 10 into crystal 27 formed at the late body growth stage.

[0058] FIG. 5C is a cross-sectional view of simulated flowlines 109 and oxygen concentrations within melt 25 at a late body growth stage calculated at a lower (e.g., 8 rpm) seed rotation rate. Crystal flow cell 18 induced by the lower seed rotation rate does not extend to the inner wall of crucible 10, but instead is excluded by buoyancy cell 17. As a result, the flow of SiO produced at the inner wall of crucible 10 to crystal 27 is disrupted, thereby reducing the oxygen concentration within crystal 27 formed at the late body growth stage at reduced seed rotation rate.

interstitial oxygen incorporated into the crystal. However, if the magnetic field strength increases beyond a certain level, further retardation in the buoyancy flow may result in decreasing the evaporation rate at the melt free surface, thus raising the interstitial oxygen levels. Due to differences in the relative contribution of buoyancy flow to the oxygen content of the crystal at the late body formation stage relative to the intermediate body formation stage as described previously herein, an adjustment to the magnet strength at the late body formation stage enables appropriate modulation of buoyancy flow to reduce oxygen within the crystal formed at the late body formation stage.

[0066] In various embodiments, the method includes regulating the magnetic field strength in at least two stages including, but not limited to, the intermediate body growth stage and the late body growth stage. In one embodiment, the method includes regulating the magnetic field strength at the intermediate body growth stage such that the magnetic field strength is approximately 0.02 to 0.05 Tesla (T) at an edge of crystal 27 at the melt-solid interface and approximately 0.05 to 0.12 T at the wall of crucible 10. In another aspect, the method includes regulating the magnetic field strength at the late body growth stage such that the magnetic field strength is approximately 150% of the magnetic field strength used during the intermediate body growth stage, corresponding to approximately 0.03 to 0.075 Tesla (T) at an edge of crystal 27 at the melt-solid interface and approximately 0.075 to 0.18 T at the wall of crucible 10.

[0067] FIGS. 8A, 8B, and 8C are cross-sectional views of simulated flowlines 109 and total speeds within melt 25 at a late body growth stage. FIG. 8A was simulated using magnetic field strengths corresponding to 50% of the magnetic field used at intermediate body growth stage (i.e. approximately 0.01 to 0.025 Tesla (T) at an edge of crystal 27 at the melt-solid interface and approximately 0.025 to 0.06 T at the wall of crucible 10). FIG. 8B was simulated using magnetic field strengths corresponding to 95% of the magnetic field used at intermediate body growth stage approximately 0.019 to 0.0475 Tesla (T) at an edge of crystal 27 at the melt-solid interface and approximately 0.0475 to 0.114 T at the wall of crucible 10. FIG. 8C was simulated using magnetic field strengths corresponding to 150% of the magnetic field used at intermediate body growth stage (i.e. approximately 0.03 to 0.075 Tesla (T) at an

WHAT IS CLAIMED IS:

1. A single crystal silicon wafer comprising:

two major, parallel surfaces, one of which is a front surface of the single crystal silicon wafer and the other of which is a back surface of the single crystal silicon wafer, a circumferential edge joining the front and back surfaces of the single crystal silicon wafer, a bulk region between the front and back surfaces, and a central plane of the single crystal silicon wafer between the front and back surfaces of the single crystal silicon wafer, wherein by the bulk region comprises an impurity comprising nitrogen at a concentration of at least about $1x10^{14}$ atoms/cm^3, germanium at a concentration of at least about $1x10^{19}$ atoms/cm^3, or a combination of nitrogen at a concentration of at least about $1x10^{14}$ atoms/cm^3 and germanium at a concentration of at least about $1x10^{19}$ atoms/cm^3, and interstitial oxygen at a concentration of less than about 6 ppma (New ASTM: ASTM F 121, 1980-1983; DIN 50438/1, 1978), and further wherein the bulk region of the single crystal silicon wafer has a resistivity of at least about 1000 ohm cm.

2. The single crystal silicon wafer of claim 1 wherein the concentration of interstitial oxygen is less than about 5 ppma.

3. The single crystal silicon wafer of claim 1 wherein the concentration of interstitial oxygen is less than about 4 ppma.

4. The single crystal silicon wafer of claim 1 wherein the concentration of interstitial oxygen is less than about 3 ppma.

5. The single crystal silicon wafer of claim 1 wherein the resistivity is at least about 3000 ohm cm.

6. The single crystal silicon wafer of claim 1 wherein the resistivity is at least about 4000 ohm cm.

7. The single crystal silicon wafer of claim 1 wherein the resistivity is at least about 5000 ohm cm.

33. A single crystal silicon ingot comprising:

a central axis, a crown, an end opposite the crown, and a main body between the crown and the opposite end, the main body having a lateral surface and a radius, R, extending from the central axis to the lateral surface, wherein the main body of the single crystal silicon ingot comprises an impurity comprising nitrogen at a concentration of at least about $1x10^{14}$ atoms/cm^3, germanium at a concentration of at least about $1x10^{19}$ atoms/cm^3, or a combination of nitrogen at a concentration of at least about $1x10^{14}$ atoms/cm^3 and germanium at a concentration of at least about $1x10^{19}$ atoms/cm^3, and interstitial oxygen at a concentration of less than about 6 ppma (New ASTM: ASTM F 121, 1980-1983; DIN 50438/1, 1978), and further wherein the main body of the single crystal silicon ingot has a resistivity of at least about 1000 ohm cm.

34. The single crystal silicon ingot of claim 33 wherein the concentration of interstitial oxygen is less than about 5 ppma.

35. The single crystal silicon ingot of claim 33 wherein the concentration of interstitial oxygen is less than about 4 ppma.

36. The single crystal silicon ingot of claim 33 wherein the concentration of interstitial oxygen is less than about 3 ppma.

37. The single crystal silicon ingot of claim 33 wherein the resistivity is at least about 3000 ohm cm.

38. The single crystal silicon ingot of claim 33 wherein the resistivity is at least about 4000 ohm cm.

39. The single crystal silicon ingot of claim 33 wherein the resistivity is at least about 5000 ohm cm.

40. The single crystal silicon ingot of claim 33 wherein the resistivity is at least about 10000 ohm cm.

41. The single crystal silicon ingot of claim 33 wherein the resistivity is at least about 15000 ohm cm.