WHAT IS CLAIMED IS:

1. A method for producing a single crystal silicon ingot from a silicon melt held within a crucible comprising:

adding polycrystalline silicon to the crucible;

heating the polycrystalline silicon to cause a silicon melt to form in the crucible;

pulling a first sample rod from the melt, the first sample rod having a first sample rod diameter;

measuring a first sample rod parameter related to the quality of the first sample rod and/or the silicon melt;

pulling a second sample rod from the melt, the second sample rod having a second sample rod diameter;

measuring a second sample rod parameter related to the quality of the second sample rod and/or the silicon melt; and

pulling a product ingot from the melt, the product ingot having a diameter, the first sample rod diameter and the second sample rod diameter being less than the diameter of the product ingot.

2. The method as set forth in claim 1 wherein the first sample rod parameter and the second sample rod parameter are the same parameter.

3. The method as set forth in claim 2 further comprising comparing the measured first sample rod parameter to the measured second sample rod parameter.

4. The method as set forth in claim 3 wherein the change of the parameter over time is measured.

5. The method as set forth in claim 1 wherein the first sample rod parameter and the second sample rod parameter are different parameters.

6. The method as set forth in any one of claims 1 to 5 wherein the first sample rod parameter and the second sample rod parameter is related to the impurity concentration of the melt and/or product ingot.

7. The method as set forth in claim 6 wherein the parameter is selected from the group consisting of the phosphorous concentration, boron concentration, aluminum concentration, gallium concentration, arsenic concentration, indium concentration, antimony concentration, total impurity concentration, dopant concentration, and resistivity of the sample rod.

8. The method as set forth in any one of claims 1 to 7 wherein polycrystalline silicon is not added to the crucible after the first sample rod is grown.

9. The method as set forth in any one of claims 1 to 8 wherein the impurity concentration of the first rod and second rod are measured, the concentration of impurities in the first and second rods being less than $1x10^{12}$ atoms/cm^3.

10. The method as set forth in claim 9 wherein the impurity concentration is measured by Fourier-transform infrared spectroscopy or by photoluminescence.

11. The method as set forth in any one of claims 1 to 10 further comprising altering a growth condition of the product ingot based at least in part on the measured first sample rod parameter and/or the measured second sample rod parameter.

12. The method as set forth in any one of claims 1 to 10 wherein the product ingot is a first product ingot and the melt is a first melt, the method further comprising altering a growth condition of a second product ingot grown from a second melt based at least in part on the measured first sample rod parameter and/or the measured second sample rod parameter.

13. The method as set forth in claim 11 or claim 12 wherein the growth condition is selected from the group consisting of a hot-zone configuration, side heater power, heater geometry, crucible liner thickness, dopant concentration, impurity and dopant evaporation, gas flow rate, and chamber pressure.

14. The method as set forth in any one of claims 1 to 13 further comprising correlating the measured first sample rod parameter and/or the measured second sample rod parameter to crucible dissolution, hot zone contamination or gas flow impurity.

15. The method as set forth in any one of claims 1 to 14 wherein the first sample rod parameter and the second sample rod parameter are the resistivity of the sample rod, the first sample rod resistivity and the second sample rod resistivity being measured by contacting the rod with a resistivity probe.

16. The method as set forth in claim 15 further comprising:

forming a planar segment on the first sample rod, the resistivity of the first sample rod being measured on the planar segment; and

forming a planar segment on the second sample rod, the resistivity of the second sample rod being measured on the planar segment.

17. The method as set forth in claim 16 wherein each planar segment extends axially from one end of the sample rod toward a second end of the sample rod.

18. The method as set forth in any one of claims 15 to 17 further comprising applying a current to the sample rod to measure a resistance of the sample rod.

19. The method as set forth in any one of claims 15 to 18 wherein each sample rod is secured by a measurement apparatus comprising a clamp that holds the sample rod while contacting the sample rod with a resistivity probe.

20. The method as set forth in any one of claims 15 to 19 further comprising annealing each sample rod in a thermal donor kill cycle prior to measuring a resistivity of the sample rod.

21. The method as set forth in any one of claims 1 to 20 wherein the diameters of the first and second sample rods are each less than 0.75 times the diameter of the product ingot, or less than 0.50 times, less than about 0.25 times or less than 0.1 times the diameter of the product ingot.

22. The method as set forth in any one of claims 1 to 21 wherein the first and second sample rods each have a length of less than about 300 mm, less than about 200 mm or less than about 100 mm.

23. The method as set forth in any one of claims 1 to 22 wherein the product ingot has a resistivity of at least about 1,500 Ω-cm, or at least about 2,000 Ω-cm, at least about 4,000 Ω-cm, at least about 6,000 Ω-cm, at least about 8,000 Ω-cm, at least about 10,000 Ω-cm, from about 1,500 Ω-cm to about 50,000 ohm-cm or from about 8,000 Ω-cm to about 50,000 Ω-cm.

24. The method as set forth in any one of claims 1 to 23 wherein the first and second sample rod each has a resistivity of at least about 1,500 Ω-cm, or at least about 2,000 Ω-cm, at least about 4,000 Ω-cm, at least about 6,000 Ω-cm, at least about 8,000 Ω-cm, at least about 10,000 Ω-cm, from about 1,500 Ω-cm to about 50,000 ohm-cm or from about 8,000 Ω-cm to about 50,000 Ω-cm.

25. A method for modeling the impurity concentration of a single crystal silicon ingot, the method comprising:

pulling a first sample rod from a silicon melt disposed in a crucible, the first sample rod having a first sample rod diameter of less than 100 mm;

measuring a first sample rod parameter related to the impurity content of the first sample rod;

pulling a second sample rod from the silicon melt, the second sample rod having a first sample rod diameter of less than 100 mm;

measuring a second sample rod parameter related to the impurity content of the second sample rod;

determining the impurity concentration of a single crystal silicon ingot based at least in part on the measured first sample rod parameter and the measured second sample rod parameter.

26. The method as set forth in claim 25 wherein the first sample rod parameter and the second sample rod parameter is the same parameter, the parameter being selected from the group consisting of the phosphorous concentration, boron concentration, aluminum concentration, gallium concentration, arsenic concentration, indium concentration, antimony concentration, total impurity concentration, dopant concentration, and resistivity of the sample rod.

27. The method as set forth in claim 25 or claim 26 wherein the first sample rod diameter and the second sample rod diameter is each less than about 50 mm, less than about 25 mm, less than about 20 mm, from about 5 mm to about 100 mm, from about 5 mm to about 50 mm, from about 5 mm to about 25 mm or from about 10 mm to about 25 mm.

28. The method as set forth in any one of claims 25 to 27 further comprising:

pulling a third, fourth, fifth, sixth, seventh, eighth, ninth and/or tenth sample rod from the melt, the diameter of each sample rod being less than about 100 mm; and

measuring a sample rod parameter related to the impurity content for each sample rod pulled from the melt.

29. The method as set forth in any one of claims 25 to 28 wherein the impurity concentration of a single crystal silicon ingot is determined from at least in part a rate of change in the difference between the measured first sample rod parameter and the measured second sample rod parameter.

30. The method as set forth in any one of claims 25 to 29 wherein the impurity concentration of a single crystal silicon ingot is determined from a model, the first sample rod parameter and the second sample rod parameter being input into to the model.

31. The method as set forth in any one of claims 25 to 30 further comprising pulling a product ingot from the melt, the single crystal silicon ingot in which the impurity concentration is determined being the product ingot pulled from the melt.

32. The method as set forth in any one of claims 25 to 31 wherein the melt is a first melt, the method further comprising:

pulling a first product ingot from the first melt:

pulling a second product ingot from a second melt, the single crystal silicon ingot in which the impurity concentration is determined being the second product ingot pulled from the second melt.

33. The method as set forth in claim 31 or claim 32 wherein the diameter of the first and second sample rods are each less than 0.75 times the diameter of the product ingot, or less than 0.50 times, less than about 0.25 times or less than 0.1 times the diameter of the product ingot.

34. The method as set forth in any one of claims 25 to 33 wherein the impurity concentration is an impurity concentration of a portion of the single crystal silicon ingot.

35. The method as set forth in any one of claims 25 to 34 wherein the impurity concentration is concentration of one or more impurities over the length of the single crystal silicon ingot.

36. The method as set forth in any one of claims 25 to 34 further comprising annealing each sample rod in a thermal donor kill cycle prior to measuring the first and second sample rod parameters.