synergistic effect between the different types of defects may also be present. Further there is a tendency that particles are present near the upper end of directional solidified silicon ingots. The upper part of the ingots must also for this reason be cut off and thereby limiting the yield.

In order to increase the yield of the silicon ingots it is desirable to minimize or totally avoid formation of the red zone, particularly in the lower end of the silicon ingots which would increase the useful part of the silicon ingots suitable for wafers and solar cell processing. It would further be advantageous if the content of particles near the upper end of the directional solidified silicon ingot could be reduced.

**Summary**

The present invention is conceived to solve or at least alleviate the problems identified above. Specifically, an object of the invention is to provide a silicon ingot and a method in which the yield when producing multicrystalline silicon ingots for solar cells from a silicon melt is increased, by improving the electrical properties (minority carrier lifetime and solar cell efficiency) of the ingot both in the red zone and in the bulk of the ingot.

The present invention comprises directionally solidified multicrystalline silicon ingots, wherein said ingot comprises elemental calcium added to a high purity silicon melt in an amount chosen from at least one of the following ranges: 5-9.99 ppmw, 10-500 ppmw, 500-550 ppmw. Also described herein is a directionally solidified multicrystalline silicon ingots, wherein said ingot comprises elemental calcium added to a silicon melt in an amount chosen from at least one of the following ranges: 5-9.99 ppmw, 10-500 ppmw, 500-550 ppmw. The yield of the directionally solidified multicrystalline silicon ingot is increased resulting in higher utilisation of the ingot when cut to wafers, thus increasing the wafer yield. Further, a silicon composition according to the present invention wherein elemental calcium is added to the silicon melt in an amount chosen from at least one of the following ranges: 5-9.99, 10-500, 10-250, 20-250, 10-150, 20-150,10-100, 10-150 ppmw. The silicon melt is chosen among polysilicon and compensated silicon.

The present invention comprises a silicon masteralloy for addition to silicon when making directionally solidified multicrystalline silicon ingot to increase yield and electrical properties of the ingot, in which said silicon masteralloy comprises

elemental calcium in an amount chosen from at least one of the following ranges: 0.5-20 weight%, 1-15 weight%, 5-15 weight%, the remaining being high purity silicon.

Further the present invention comprises a silicon masteralloy for increased yield in multicrystalline silicon ingots in which said silicon masteralloy comprises elemental calcium in an amount chosen from at least one of the following ranges: 0.5-20 weight%, 1-15 weight%, 5-15 weight%, the remaining being high purity silicon. Furthermore, said silicon masteralloy is optionally added to a silicon melt when directionally solidifying silicon ingot.

Furthermore a method for increasing the yield of directional solidified multicrystalline silicon ingots is also comprised in which elemental calcium is added to the silicon melt in an amount chosen from at least one of the following ranges: 5-9.99 ppmw, 10-500 ppmw, 500-550 ppmw prior to subjecting the silicon melt to directional solidification in a crucible. In the present invention calcium is added to the silicon melt in an amount chosen from at least one of the following ranges: 5-9.99, 10-500, 10-250, 20-250, 10-150, 20-150,10-100, 10-150, 500-550 ppmw.

The present invention comprises a method for preparing a silicon masteralloy for increasing the yield of multicrystalline silicon ingots, wherein said method comprises addition of elemental calcium to molten high purity silicon in an amount chosen from at least one of the following ranges: 0.5-20 weight%, 1-15 weight%, 5-15 weight%, homogenizing the resulting alloy and solidifying said alloy to provide said silicon masteralloy. Also described herein is a method for preparing a silicon masteralloy for increasing the yield of multicrystalline silicon ingots, in which said method comprises addition of elemental calcium to a molten silicon in an amount chosen from at least one of the following ranges: 0.5-20 weight%, 1-15 weight%, 5-15 weight%, homogenizing the resulting alloy and solidifying said alloy to provide said silicon masteralloy. Said silicon masteralloy is optionally added to a silicon melt when directionally solidifying a silicon ingot.

The silicon melt which also should be understood as molten silicon can be chosen among at least one of the following: a high purity silicon melt, compensated silicon and polysilicon. According to the invention said silicon masteralloy described above is added to a charge comprising silicon for producing multicrystalline silicon ingots with increased yield. In the present invention silicon ingots with increased yield are produced by directionally solidifying multi-crystalline silicon ingots from said silicon melt. The present invention also concerns use of a master alloy comprising elemental calcium in an amount chosen from at least one of the following ranges: 0.5-20