vacancies or silicon interstitials aggregate to form larger units and form defects such as FPDs ("flow pattern defects") or Lpits ("large etch pits"). In general, the formation of such defects must be avoided, but this is only accomplished if v/G remains within the narrowest possible limits during the pulling of the section having a diameter that remains constant. The requirement to match the diameter in the section having a diameter that remains constant to the desired diameter and the requirement to keep v/G within narrow limits lead to a conflict because, on the one hand, an adaptation of the pulling rate v_p to an altered crystallization rate v caused by temperature fluctuations in the melt readily has the consequence that the narrow limits for v/G are left and, on the other hand, a correction of the altered crystallization rate v by changing the supply of heat to the melt by means of a heating source arranged around the crucible brings about a deviation from the desired diameter. It is difficult, therefore, to regulate the diameter to a desired diameter without having to disregard the regulation of v/G, and vice versa.

EP 1 541 721 A1 describes measures for regulating the diameter and measures for regulating v/G, but they cannot resolve the abovementioned conflict.

Embodiments~~It is an object~~ of the present invention seek to offer an improved method which comprises efficient regulation of the diameter and at the same time reliably avoids thus having to accept the formation of undesirable defects such as FPDs or Lpits.

According to an aspect of the present invention, there is provided a method for pulling a single crystal composed of silicon with a section having a diameter that remains constant, comprising

providing a first heating source, which supplies heat to the single crystal and to a region of a melt that adjoins the single crystal, the first heating source being arranged above the melt;

providing a second heating source which is arranged around a crucible;

pulling the single crystal with a predefined pulling rate v_p having the unit [mm/min], wherein predefined curves for v_p, for the heating power of the first heating source, and for the heating power of the second heating source, for the disturbance-free case were chosen such that the quotient v/G of the crystallization rate v and the axial temperature gradient D at the phase boundary between the growing single crystal and the melt corresponds to a critical value at which neither vacancies nor silicon interstitials are formed in excess; and

regulating the diameter of the single crystal in the section having a diameter that remains constant to a predefined diameter by means of regulating the heating power of the first heating source in such a way that diameter fluctuations are corrected with a period duration T that is not longer than $(2 * 18\ mm)/v_p$, wherein the heating power of the second heating source is used as a manipulated variable of a downstream regulation for bringing back deviations of the heating power of the first heating source from the predefined curve, if the deviations persist over a long period of time.

According to an embodiment of the present invention, there is provided~~This object is achieved by means of~~ a method for pulling a single crystal composed of silicon with a section having a diameter that remains constant, comprising

pulling the single crystal with a predefined desired pulling rate v_p having the unit [mm/min]; and

regulating the diameter of the single crystal in the section having a diameter that remains constant to a predefined desired

Patent Claims

1. A method for pulling a single crystal composed of silicon with a section having a diameter that remains constant, comprising
pulling the single crystal with a predefined desired pulling rate v_p having the unit [mm/min]; and
regulating the diameter of the single crystal in the section having a diameter that remains constant to a predefined desired diameter by means of regulating the heating power of a first heating source, which supplies heat to the single crystal and to a region of the melt that adjoins the single crystal, and which is arranged above the melt, in such a way that diameter fluctuations are corrected with a period duration T that is not longer than (2 * 18 mm)/v_p.

2. The method as claimed in claim 1, comprising
regulating the heating power of the first heating source by means of the heating power of a second heating source, which supplies heat to the single crystal and to the melt and which is arranged around a crucible containing the melt.

PATENT CLAIMS

1. A method for pulling a single crystal composed of silicon with a section having a diameter that remains constant, comprising

providing a first heating source, which supplies heat to the single crystal and to a region of a melt that adjoins the single crystal, the first heating source being arranged above the melt;

providing a second heating source which is arranged around a crucible;

pulling the single crystal with a predefined pulling rate v_p having the unit [mm/min], wherein predefined curves for v_p, for the heating power of the first heating source, and for the heating power of the second heating source, for the disturbance-free case were chosen such that the quotient v/G of the crystallization rate v and the axial temperature gradient D at the phase boundary between the growing single crystal and the melt corresponds to a critical value at which neither vacancies nor silicon interstitials are formed in excess; and

regulating the diameter of the single crystal in the section having a diameter that remains constant to a predefined diameter by means of regulating the heating power of the first heating source in such a way that diameter fluctuations are corrected with a period duration T that is not longer than (2 * 18 mm)/v_p, wherein the heating power of the second heating source is used as a manipulated variable of a downstream regulation for bringing back deviations of the heating power of the first heating source from the predefined curve, if the deviations persist over a long period of time.