

Claims

1. A semiconductor wafer made of single-crystal silicon with a center, an edge and a radius R between the center and the edge, wherein the semiconductor wafer has:
 - an oxygen concentration of not less than 4.9×10^{17} atoms/cm³ and not more than 5.85×10^{17} atoms/cm³;
 - a nitrogen concentration of not less than 5×10^{12} atoms/cm³ and not more than 1.0×10^{14} atoms/cm³;
 - a hydrogen concentration of not less than 3×10^{13} atoms/cm³ and not more than 8×10^{13} atoms/cm³;
 - BMD seeds whose density meaned over the radius of the semiconductor wafer, determined by IR tomography, is not less than 1×10^5 cm⁻³ and not more than 1×10^7 cm⁻³;
 - surface defects whose density meaned over the radius is not less than 1100 cm⁻² determined by optical microscopy after heat treatments of the semiconductor wafer at a temperature of 900°C over a period of 8 h in an atmosphere of nitrogen and at a temperature of 1100°C over a period of 2 h in an atmosphere of oxygen and hydrogen; and
 - BMDs, whose density is not lower than a lower limit of 5×10^8 /cm³ determined along the radius from a radial position $r = R/3$ to a radial position $r = R/1.15$ by IR tomography after heat treatments of the semiconductor wafer at a temperature of 780°C over a period of 3 h and at a temperature of 1000°C over a period of 16 h.
2. The semiconductor wafer as claimed in claim 1, wherein a frontside of the semiconductor wafer is covered with an epitaxial layer made of silicon.
3. The semiconductor wafer as claimed in claim 2, wherein the density of BMDs is not less than 3×10^8 /cm³ and not more than 2.5×10^9 /cm³ determined from the center to the edge of the semiconductor wafer for an edge exclusion of 1 mm and evaluated by IR tomography after heat treatments of the semiconductor wafer at a temperature of 780°C over a period of 3 h and at a temperature of 1000°C over a period of 16 h.
4. The semiconductor wafer as claimed in claim 2 or claim 3, wherein the density of BMDs varies by not more than 80% based on a mean density, determined along the radius from a radial position $r = R/1.0791$ to a radial position $r = R/1.0135$ and

evaluated by IR tomography after heat treatments of the semiconductor wafer at a temperature of 780°C over a period of 3 h and at a temperature of 1000°C over a period of 16 h.

- 5 5. A process for producing a semiconductor wafer from single-crystal silicon, comprising
pulling a single crystal from a melt as per the CZ method at a pulling velocity V , wherein the melt is doped with oxygen, nitrogen and hydrogen and the single crystal grows at a crystallization interface;
10 controlling the incorporation of oxygen, nitrogen and hydrogen in a section of the single crystal having a uniform diameter in such a way that the oxygen concentration is not less than 4.9×10^{17} atoms/cm³ and not more than 5.85×10^{17} atoms/cm³, the nitrogen concentration is not less than 5×10^{12} atoms/cm³ and not more than 1.0×10^{14} atoms/cm³ and the hydrogen concentration is not less than 3×10^{13} atoms/cm³
15 and not more than 8×10^{13} atoms/cm³;
controlling the pulling velocity V such that it is within a span ΔV within which the single crystal in the section having a uniform diameter grows in a P_v region, wherein the pulling velocity V is in a subrange of the span which comprises 39% of the span and a lowest pulling of velocity of the subrange is 26% greater than a pulling velocity $V_{Pv/Pi}$ at
20 the transition from the P_v region to a P_i region; and
separating the semiconductor wafer from the section of the single crystal having a uniform diameter.
6. The process as claimed in claim 5, comprising pulling the single crystal in an
25 atmosphere comprising hydrogen, wherein the partial pressure of the hydrogen is not less than 5 Pa and not more than 15 Pa.
7. The process as claimed in claim 5 or claim 6, comprising increasing the partial pressure of the hydrogen once the section of the single crystal having a uniform
30 diameter has reached an axial length greater than 50% of an intended axial length of this section.
8. The process as claimed in any of claims 5 to 7, wherein an epitaxial layer of silicon is deposited on a frontside of the semiconductor wafer.

9. The process as claimed in claim 8, wherein before deposition of the epitaxial layer a step of subjecting the single crystal or the semiconductor wafer to a heat treatment, which by stabilizing the BMD seeds protects them from being dissolved during
5 deposition of the epitaxial layer, is eschewed.