

THIS SHEET HAS BEEN
REPLACED

9804249-2

1PDS

sp
8

This Sheet Has Been Replaced



**Process and heating device for melting
semiconductor material**

5 The invention relates to a process for melting semiconductor material in a crucible which is located in a container. The invention also relates to a heating device which is suitable for carrying out the process.

10 The process is preferably used for the production of single crystals using the Czochralski method. In order for it to be possible for a single crystal to be pulled from a melt using this method, it is firstly necessary to melt the semiconductor material, which is customarily placed in a quartz crucible. The energy needed for this is usually applied by a fixed heating device which is arranged around the crucible.

15 During the melting procedure, the crucible is exposed to high temperature. As a result of this, so-called pitting corrosion of the crucible material takes place, with the production of particles which may subsequently make it impossible to grow the single crystal without dislocations. The temperature at the crucible wall, as well as the melting time, should therefore be minimised.

20 The invention relates to a process for melting semiconductor material in a crucible which is located in a container and is enclosed by a fixed heating device, wherein a heater of a displaceable heating device is lowered from a lock chamber above the container through an open shut-off valve into the container in the direction of the semiconductor material, and the semiconductor material is melted using the fixed heating device and the lowered heater, and the heater is raised back out of the container into the lock chamber after the semiconductor material has been melted.

30 The invention also relates to a heating device which is suitable for carrying out the process. A heating device is proposed which is displaceable and comprises a heater which can be lowered from a lock chamber above the container through an open shut-off valve into the

container in the direction of the semiconductor material, and raised back into the lock chamber.

5 The invention permits rapid melting of the semiconductor material starting from the center of the semiconductor material charge, the crucible material being protected since a substantial proportion of the required energy is not introduced through the crucible wall. Furthermore, the process does not have any effect on the procedure involved in the actual crystal production, so that tried and tested pull conditions can be kept unchanged.

10 The invention will be explained in more detail below with the aid of a figure. The figure schematically shows a sectional representation of the side view of a system for pulling single crystals using the Czochralski method. Only those features necessary for explanation of the invention are shown.

15 The crucible 2, filled with semiconductor material 1, is located in a container 3 which may be flushed with inert gas and evacuated. A fixed heating device 4 encloses the crucible. If appropriate, an additional fixed heating device may further be provided which is arranged under the bottom of the crucible and is referred to as a bottom heater. Above the crucible, a lock chamber 5 is flanged onto the container. It accommodates a displaceable heating device having a heater 6 whose front side is directed at the semiconductor material and whose rear side is insulated by thermal insulation 7. According to the embodiment which is represented, the heater comprises two heating elements, which are mounted on the ends of a tube 8 and a shaft 9. The heater is preferably designed in the form of an electrical heating resistor or induction heater, and is made of graphite, for example. The required electric current (direct current or alternating current, or direct current modulated with alternating-current components) is preferably delivered via the tube 8 and the shaft 9. The tube and the shaft can be raised and lowered together axially. The gap between the tube and

the shaft is used for delivering inert gas to the container 3, or for discharging waste gas from the container. The heating device further comprises a bell 10 which can be evacuated and flushed with inert gas, and is placed over the insulation 7 and the heater 6. The bell is supported on a support plate 11 of the lock chamber 5. Vacuum-tight seals 12 between the bell and the support plate, and between the bell and the tube 8, form a gas-tight barrier. The interior of the container can be separated in gas-tight fashion from the interior of the lock chamber using a shut-off valve 13.

In order for the semiconductor material to be melted, the bell is evacuated and flushed with inert gas, and the shut-off valve 13 is opened. The tube 8 and the shaft 9 are lowered until the heater 6 has reached a position as close as possible to the surface of the semiconductor material. The distance between the surface of the heater and the surface of the semiconductor material is chosen large enough to exclude the possibility of contact with the semiconductor material to be melted. The heater is preferably designed in such a way that it fits into a tubular or conical heat shield 14, if the latter is built into the container, suspended over the crucible. The energy for melting the semiconductor material is applied by the combination of the fixed heating device 4, a bottom heater which may possibly be present, and the lowered heater 6. It is preferable to distribute the energy contributions in such a way that the semiconductor material melts as a function of its position in the crucible, and semiconductor material which is in contact with the crucible wall melts last. It is particularly preferable if the front of molten semiconductor material moves radially outward from the middle of the crucible toward the crucible wall, if the melting procedure is observed from a position above the crucible.

After the semiconductor material has been melted, the heater 6 is raised back into the lock chamber, and the shut-off valve 13 is closed. The heating device is then removed from the lock chamber through a door 15. The

pulling of a single crystal is then commenced by lowering
a seed crystal using a conventional pulling device which
is arranged above the lock chamber (not shown in the
figure), through the lock chamber, if appropriate
5 evacuated and flushed with inert gas, to the surface of
the molten semiconductor material.

As an alternative to the procedure described
above, the displaceable heating device with the lock
chamber may be removed from the container, and, for
10 example, moved to another container. A pulling device is
put in place of the lock chamber that has been removed.



Patent Claims

1. A process for melting semiconductor material in a crucible which is located in a container and is enclosed by a fixed heating device, wherein a heater of
5 a displaceable heating device is lowered from a lock chamber above the container through an open shut-off valve into the container in the direction of the semiconductor material, and the semiconductor material is melted using the fixed heating device and the lowered
10 heater, and the heater is raised back out of the container into the lock chamber after the semiconductor material has been melted.

2. The process as claimed in claim 1, wherein the displaceable heating device is removed through a door in
15 the lock chamber after the semiconductor material has been melted.

3. The process as claimed in claim 1 or claim 2, wherein the semiconductor material is melted as a function of its position in the crucible, and
20 semiconductor material which is in contact with the crucible is melted last.

4. A heating device for melting semiconductor material in a crucible, the crucible being located in a container, and the heating device transmitting energy to
25 the semiconductor material from a position above the crucible, wherein the heating device is displaceable and comprises a heater which can be lowered from a lock chamber above the container through an open shut-off valve into the container in the direction of the
30 semiconductor material, and raised back into the lock chamber.

5. The heating device as claimed in claim 4, wherein the heating device can be removed through a door in the lock chamber.