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GROWTH OF SEMICONDUCTOR COMPOUND SINGLE CRYSTAL InSb BY FLOATING ZONE METHOD
M-3

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Floating zone methods have potential applications in growing single high-quality semiconductor crystals. In this method, melts can be sustained without containers and, therefore, are free from contamination from the containers. On the ground, however, the maximum stable length of the floating liquid column L_{max} that can be sustained by its surface tension against the gravitational force is restricted as $L_{max} = 2.84 \sqrt{\gamma/\rho g}$, where γ, ρ are the surface tension and density of the liquid, respectively, and g the gravitational acceleration. This gravitational restriction makes it impossible to grow large diameter, single crystals of materials that have small surface tensions or high densities, e.g., InSb and GaSb, etc. In the microgravity environment, the maximum stable length of the liquid column dramatically increases and is written as $L_{max} = 2\pi R$, where R is the radius of the cylindrical liquid column. The use of the floating zone method in the microgravity environment may allow growth of large diameter, single crystals of many materials. Moreover, the absence of the gravity-driven convention could reduce the temperature fluctuations at the growing interface and thus could lead to improvements in crystal quality.

The main objective of this project is to use the Image Furnace to study a large diameter, (20 mm) single crystal of InSb under microgravity conditions. The behavior of the liquid column is recorded on the VTR tapes and is compared with what is expected theoretically. The single crystal grown in space is characterized by comparing it with single crystals grown on the ground with respect to crystallographic and electronic properties. The goal of this project is to confirm the effects of the microgravity on the single crystals.

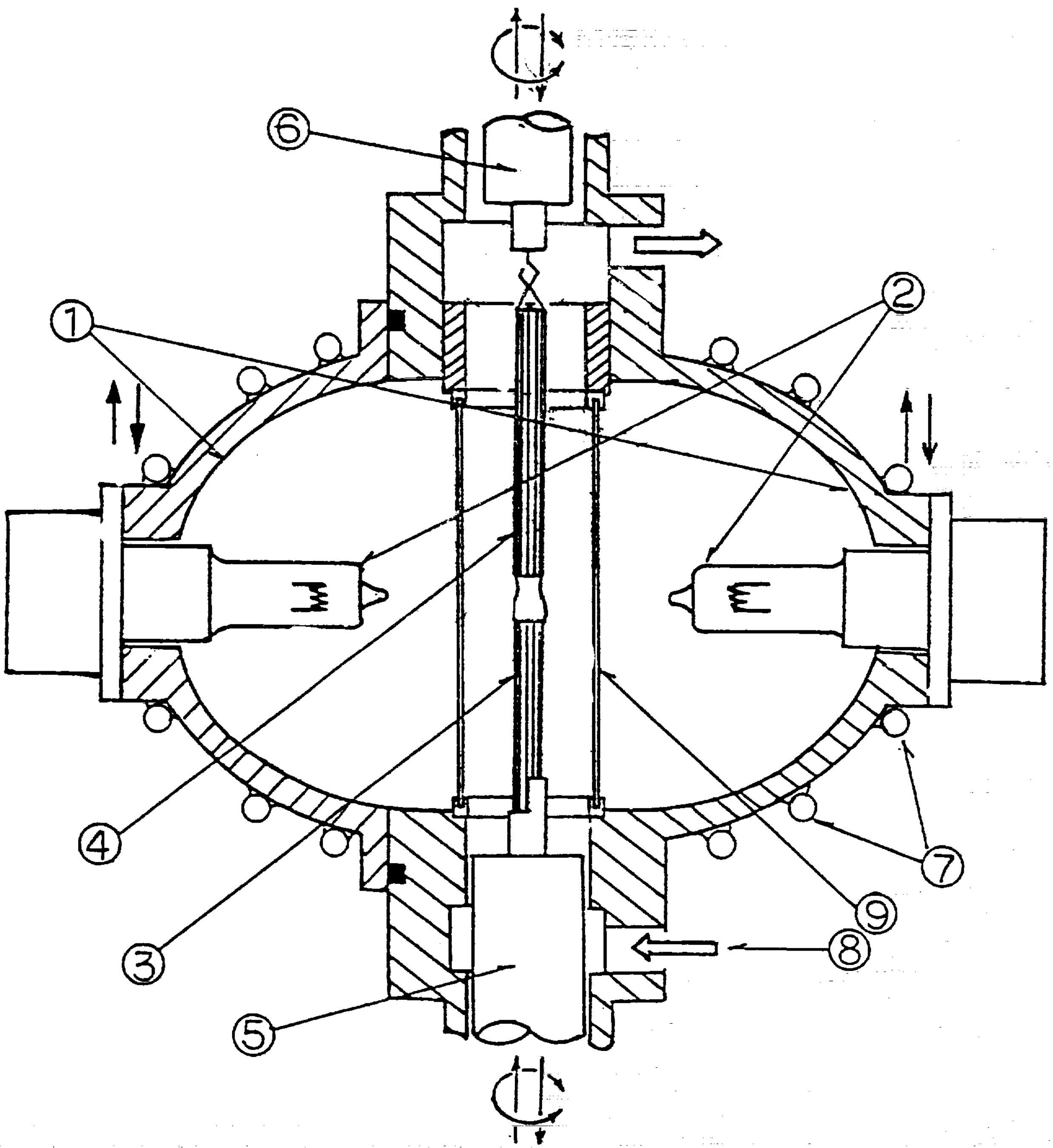


Figure 1. Schematic view of the double ellipsoidal image furnace: (1) double ellipsiodal mirror; (2) hallogen lamps; (3) single crystalline rods of InSb; (4) polycrystalline rods of InSb; (5) upper shaft; (6) lower shaft; (7) cooling water; (8) atmospheric gas; (9) quartz tube.

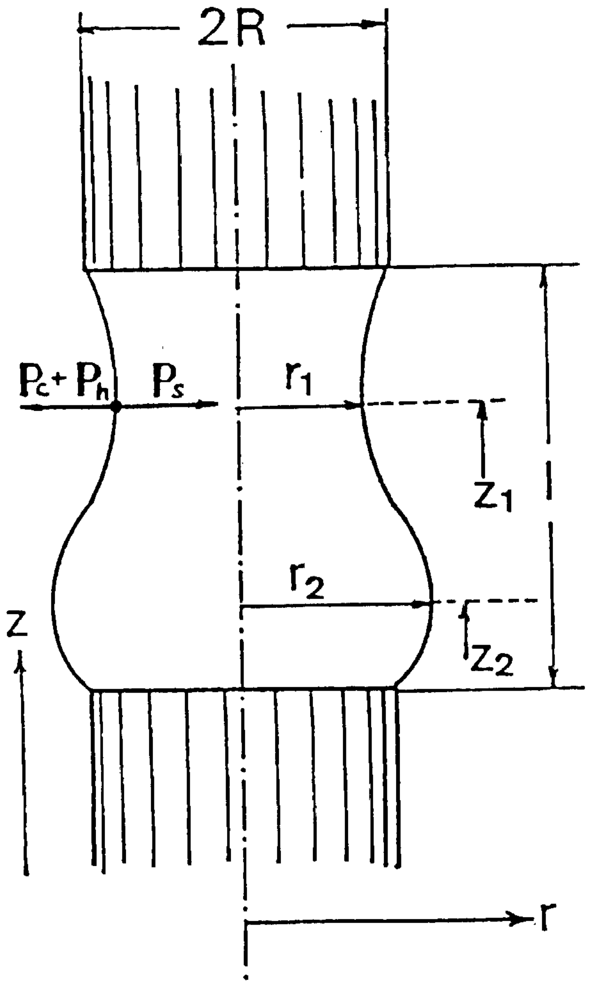


Figure 2. Bottle-shaped floating zone which exhibits a neck and a belly at the position of Z_1 and Z_2, respectively. Pc denotes the pressure due to the centrifugal force, Ph the hydrostatic pressure, and Ps the pressure due to the surfae tension.

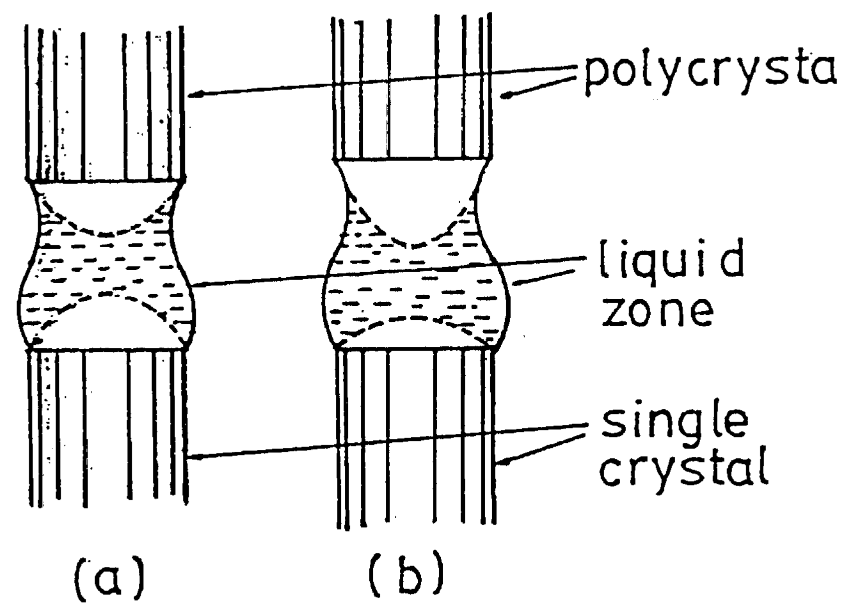
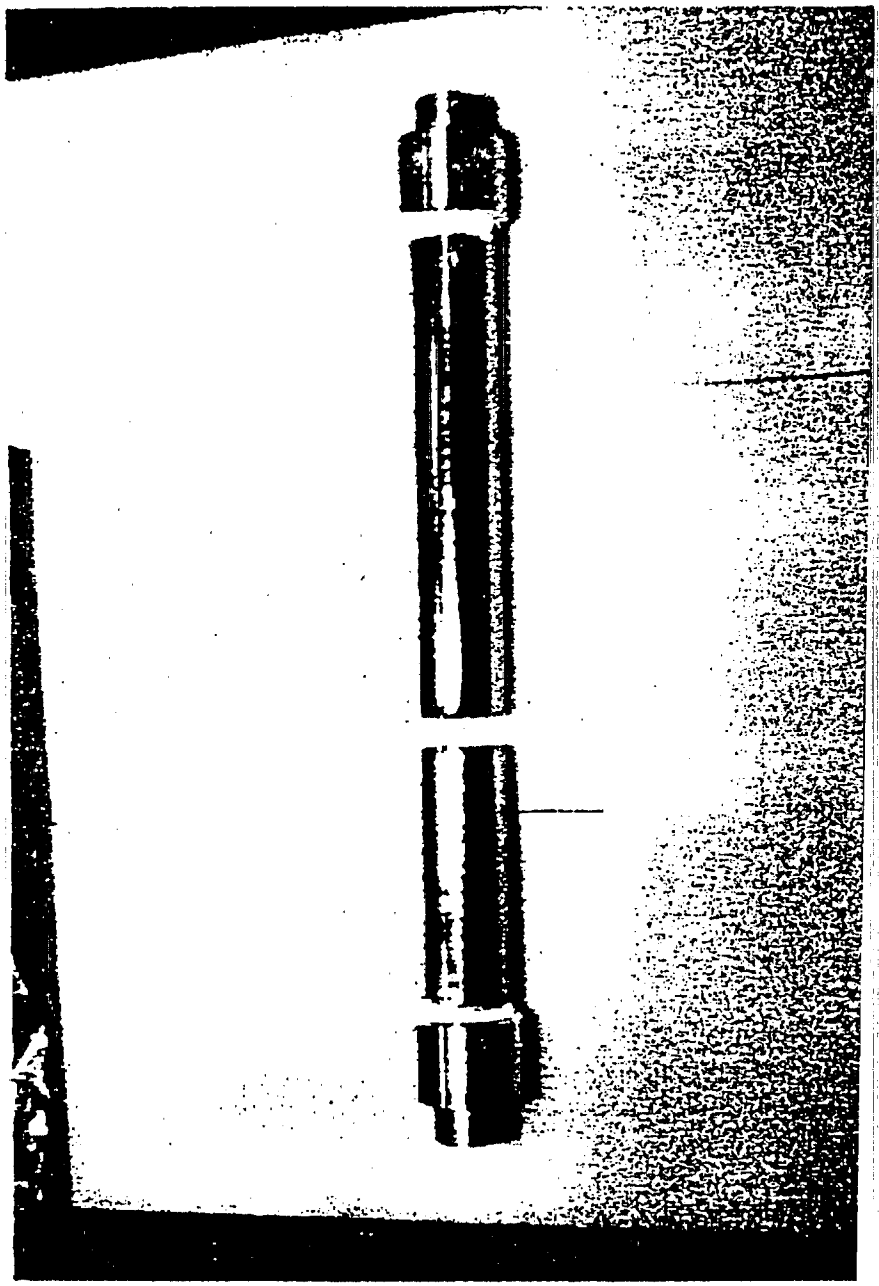


Figure 3. Solid liquid interfaces in floating zones: (a) the floating zone without travel; (b) the floating zone traveling with the velocity v.



1. formation of melt-drops at the both ends
2. joining the melts together
3. back-melting the seed end
4. floating zone growth
5. decreasing the diameter and pulling apart both the melts

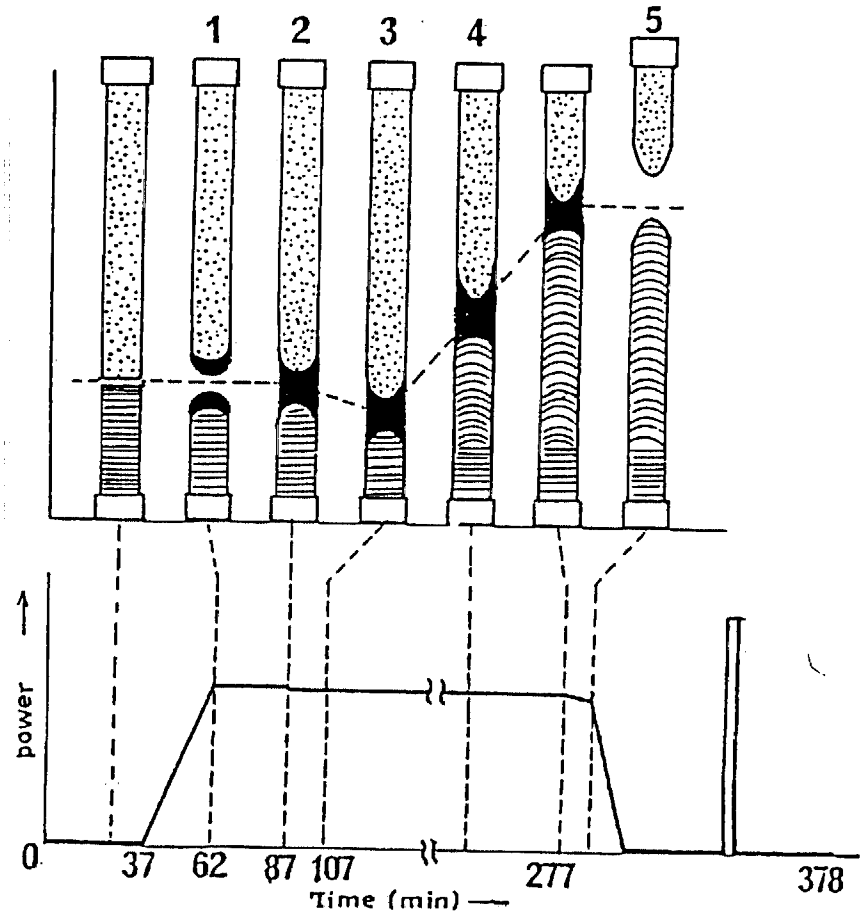
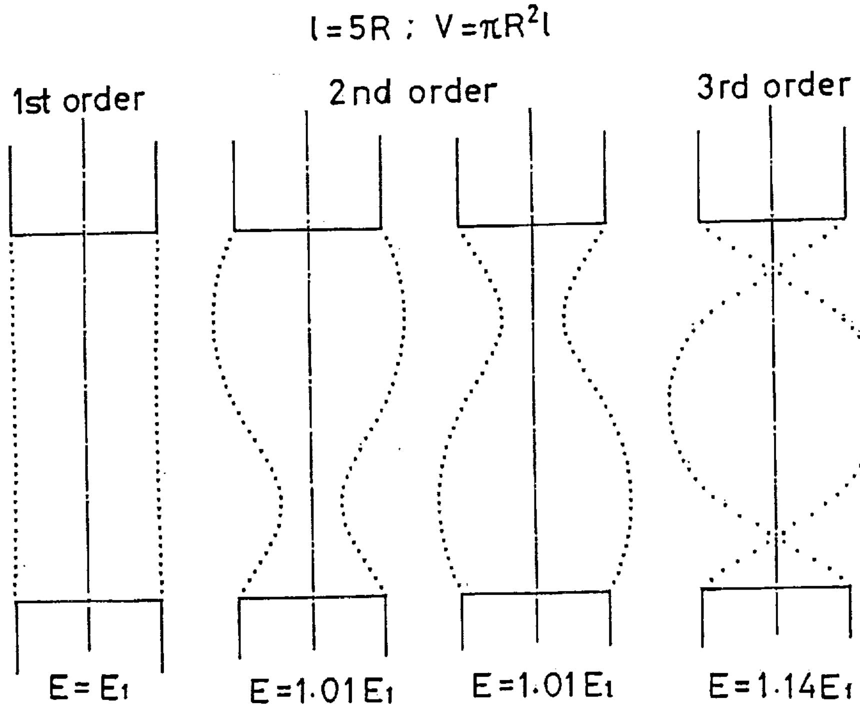
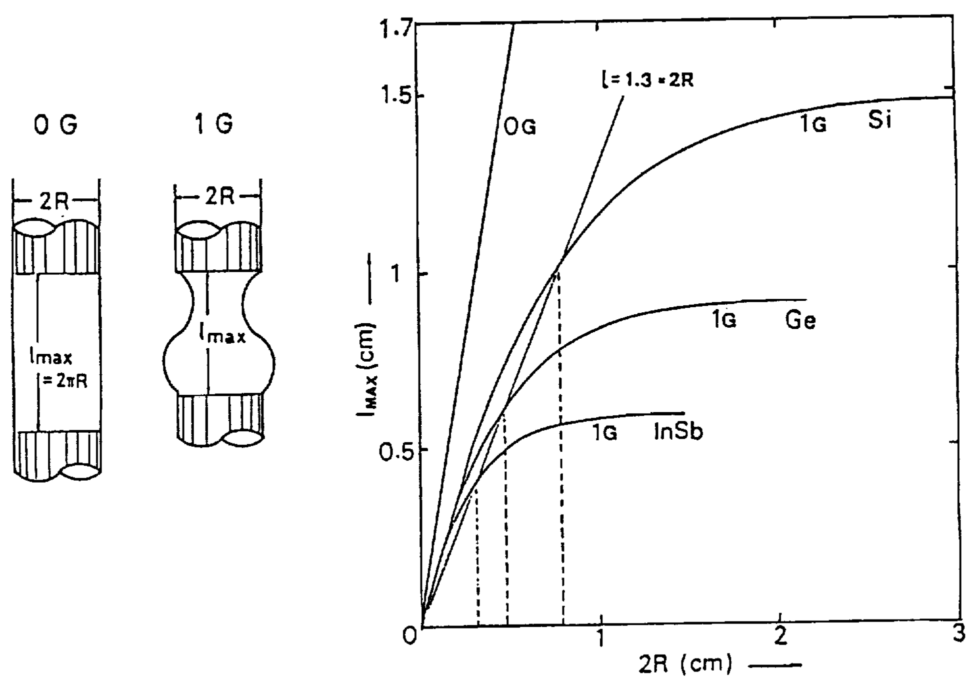


Figure 4





Maximum stable length of liquid zone l_{MAX} versus sample diameter 2R

Figure 5.