B-5-4 Liquid phase epitaxy apparatus for multiple layers utilizing centrifugal forces

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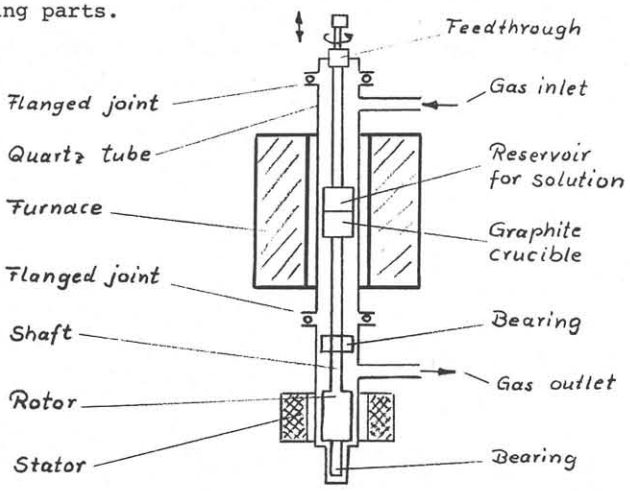
For many optical and electrical devices, high quality layers of compound semiconductors are a necessary requirement. Liquid phase epitaxy (LPE) is a reliable and economic technique to prepare such layers for device application. The preparation of multiple layers by LPE has been achieved by the introduction of the sliding boat technique. This technique is widely used by now and is applied in various modifications.

To overcome some difficulties which are still connected with sliding boat techniques (complete removal of melt, avoidance of surface scratching during melt removal, production of very thin layers) we looked for an alternative possibility to grow thin multiple layers by LPE. We developed an LPE apparatus in which the solutions are transported to the substrates and removed from the subtrates by centrifugal forces. The crucible does not contain any sliding parts.

Liquid phase epitaxy apparatus, schematic cross section



The growth system is a vertical one and consists essentially of a quartz tube surrounded by a furnace. The crucible is fixed at the top of a shaft running through the tube and extending into the center of the furnace. The lower end of the shaft is connected to a rotor. A stator outside the quartz tube drives the rotor with variable speed up to 5000 revolutions per minute. The crucible is symmetrical with respect to the rotational axis of the shaft and has small stock bins to hold the solutions. These stock bins, which are adjacent to the center of rotation, have slotted openings ending in a narrow gap that points away from the axis. Substrates can be fixed on one or on both sides of the gap. The outer shell of the crucible constitutes a container that collects the residue solution.

When the substrates are in place, the crucible is heated to the desired growth temperature. When the crucible assembly has reached thermal equilibrium, the system is rotated fast enough for the centrifugal forces to exceed the forces of surface and interfacial-tension components. The solution then enters the gap and passes over the substrates' surfaces to deposit the epitaxial layers. When the growth process has been completed, residue solution is removed from the crystal surface by raising the rotational speed of the crucible. Simultaneously, the residue solution being collected in the outer shell of the crucible is transported into containers which are situated above the stockbins. Then, the crucible rotation is stopped. In the containers, the recycled solutions get saturated again. From there, the stockbins in the crucible are refilled for deposition of the next layer. Every time after the stockbins have been filled, the crucible is rotated. With several containers for solutions of different composition, multiple layers can be deposited in a single step process. The operation of the apparatus in detail and the properties of GaAs multiple layers grown in the system are described.