A simple reactor for growth of HgCdTe films using LPE technique

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Abstract. A reactor for growth of $\text{Hg}_{1-x}\text{Cd}_x\text{Te}$ epilayers by liquid phase epitaxy has been designed and developed. The layers have been successfully grown using this liquid phase epitaxy (LPE) reactor.

Keywords. Reactor; liquid phase epitaxy; mercury cadmium telluride.

1. Introduction

Mercury cadmium telluride (MCT) is a strategic material for IR detector arrays and liquid phase epitaxy of $\text{Hg}_{1-x}\text{Cd}_x\text{Te}$ on CdTe substrate is widely used for growth of large area films (Parker *et al* 1988). Of the available methods, LPE is the widely acceptable technique for growing MCT layers.

The growth of such epilayers by LPE requires a sophisticated equipment having provisions such as evacuation before charging, pressurization to contain mercury in the melt material at elevated temperatures, substrate transfer from the melt to room temperature zone etc. in addition to having a programmable linear cum rotary drive. Such an equipment is not available commercially. An attempt has been made to design and develop a reactor for growing epilayers in the laboratory. In this paper, the various design features and constructional details of the reactor are described. The equipment developed in this laboratory has been successfully used for growing epitaxial layers of HgCdTe from tellurium-rich melt.

2. Description

A schematic diagram of the reactor is shown in figure 1. The reactor consists of an enclosed 60 mm internal diameter, 316 stainless steel (s.s.) tube having a water jacket and a flange with viton 'O' ring seal at the top. A gate valve having knife edge seals with metallic gaskets at both ends, is fixed to the flange with the help of a distance piece. The other end of gate valve is also provided with a distance piece which is further connected to another distance piece having flange provided with a pressure seal capable of withstanding a pressure of two atmospheres. A window and hand-hole is also provided to facilitate viewing/removal and loading of substrate after pulling. A 20 mm diameter, 316 s.s. pipe passes through this seal. This ground s.s. pipe carries a quartz substrate holder for fixing the substrate and is used for transporting the substrate towards and away from the quartz melt pot which is kept at the bottom of s.s. tube.

The ground s.s. pipe which is closed at the other end is connected to a 'Crystlox' rotary-cum-translational mechanism which provides rotary and linear motion as and when required. The controller attached to this mechanism can be used for attaining the desired rpm and linear feed rates.

Figure 1. LPE reactor. (1. s.s. tube, 2. water jacket, 3. flange, 4. distance piece, 5. distance piece, 6. gate valve, 7. flange, 8. s.s. pipe, 9. pressure seal, 10. crystlox, 11. coupling, 12. window/hand hole, 13. pumping/gas port, 14. guide plate, 15. melt pot, 16. substrate holder and 17. furnace).

We designed and developed our own double lip-type seal for this reactor. The reactor was also provided with test ports and connectors for evacuation and pressurizing the system. Resistance heaters with gold-plated glass covering has been used for heating the melt, placed in a quartz pot (about 350 g). Necessary provision to bring the heating elements to the desired position has been made in the furnace casing and a wheeled cage provided to move the reactor away, when desired.

3. Growth process

Initially CdTe substrate is mounted on the substrate holder. About 350 g of melt material ($\text{Hg}_{0.8}\text{Cd}_{0.2}\text{Te}$) in a quartz pot is loaded in the growth chamber. The system is then assembled and alignment checks carried out. The reactor is then evacuated with the help of a vacuum system. Hydrogen gas is then charged into the reactor so as to raise the pressure within about 2 bars. Gate valve keeps the growth chamber and substrate holder isolated during this operation.

After the melt attains 468°C , gate valve is opened and substrate holder is lowered to the desired depth with linear drive of 'Crystlox', while rotating the substrate at about 15 rpm. The melt is then stirred at this rpm for about 1 h. The melt temperature is reduced at the rate of 2°C/h . The substrate holder is then withdrawn from the melt at a linear speed of about 90 cm/h, while rotational speed is increased to about 90 rpm to drain away excess melt etc. Substrate holder is brought to rest after it crosses the gate valve. The melt in the reactor is then isolated by closing the gate valve. The upper chamber port can then be opened to remove the substrate and for subsequent fresh substrate loading.

4. Conclusion

The equipment has been commissioned successfully and is being used for the growth of epitaxial layers of HgCdTe on CdTe substrate from tellurium rich melt. The grown layers have been characterized and results will be reported in due course.

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Reference

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