

Annual Technical Report

Year 1

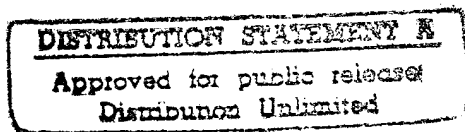
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AASERT In-Situ Growth Monitoring of Molecular Beam Epitaxy Processes



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Introduction

This is the first year technical report on the ARPA/ARO AASERT grant DAAH04-94-G-0363 titled "In-Situ Growth Monitoring of Molecular Beam Epitaxy Process." This grant augments the parent grant N00014-92-J-1931. This program addresses issues toward achieving real time control of III-V semiconductor epitaxial film. This program addresses issues toward achieving real time control of III-V semiconductor epitaxial film growth.

Experimental

Work on this project has resulted in many changes to the computer control of the MBE growth chamber. The first and most basic of changes was a total revision of the computer program used for thickness control during growth. The software has been totally redesigned on all levels including the user interface. The interface is more intuitive, easier to use, and drastically reduces data entry for multiple layers and so decreases the possibility of error. A second objective for the revised program is increased modularity and expandability to allow for addition of features and modification of existing features. The program was written using C++ in the Windows environment. The object oriented nature of the software has proved to be very effective in terms of modularity, expansion, and modification. Another of the objectives is increased robustness. This objective has been met in that the software has not been demonstrated to fail.

We have called this software MBEGUI. This stands for MBE Graphics User Interface. The program allows the user to enter shutter control and thickness information for a sequence of layers. Repetitive cycles may also be specified. When the program is run, the shutters are opened and closed by the software. The shutter close time is calculated based on the desired thickness entered by the user and the growth rate of the sample. Previous data points are used to project an expected shutter close time and this time continuously updated until the shutter is closed. This method of thickness control allows for consistent layer thickness in spite of variables such as varying K-cell temperature or possibly a depleting K-cell. A recent addition to the program has been an option for composition monitoring. The user may specify a composition growth for the layer and the program will then monitor the composition so the user can know exactly what composition has been grown. The objective for this feature is to control the composition during growth. However, this has yet to be implemented.

While developing the new control software we have run several experiments. By normal incidence reflectance measurement we have shown the control of the Fabry-Perot cavity layer thickness is within 0.5%. We have also grown multiple 25Å thin GaAs quantum wells. From 77 K photoluminescence data demonstrate a variation of quantum well thickness is less than 0.5 ML.

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