Utilization of Pulsed Laser Deposition (PLD) in Quantum Dot Optical Detectors

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By

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Ayman

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Chapter 4: Thin Film Characterization Techniques

Chapter 5: Experimental results and Discussion

Part I: Design of PLD System and Experimental Setup

Aim of the work

- Design and performance of a Pulsed Laser Deposition System including;
  The PLD chamber
  -the vacuum system
  - Mechanical feed through
  -electrical feed through
  -motor for rotation of the target and its driver
  - Temperature control system for the substrate holder heater

- thin film production using this PLD
- Single Quantum dots lyre
- Multi quantum dots lyre

- Thin film thickness measurements
- Thin film diagnostics;
  - Optical microscope
  - Electron microscope
  - XRD
  - EDX
  - AFM
  - I-V Characteristics
  - Optical detector measurements

Abstract

Now a day, it is well known that the material characteristics could be changed by changing the size keeping the chemical compositions intend. Thus, the possibility to tailor the material properties by varying the size alone provided the mankind a revolutionary wisdom of materials science, which enabled the emergence of a new branch of technology called Nanotechnology.

On the other hand, Pulsed Laser Deposition (PLD) has been used for epitaxial growth of thin films and multilayer/super lattice of complex materials.

Its aimed in the present work to design a homemade system for PLD based on XeCl Eximer Laser 308 nm, energy per pulse 0-13 mJ, pulse duration 6 ns and reputation rate 0-200 Hz.

PLD Vacuum chamber, vacuum system, mechanical feed through and electrical feed through including rotation of the target, substrate and heating the substrate. The deposition parameter were optimized for the given material including energy per pulse, distance between target and substrate, type of the substrate, in addition temperature to get crystalline or amorphous layers, number of Laser pulses, ambient gas and pressure.

As well as the orientation of the sample-substrate and the Laser beam.

According to the optimization the parameters, we obtained reliable system in which that we obtained exactly the same layers when we used the number of pulses and the same deposition parameter which indicates the reproducibility of the here system. More over we obtained same layer of GeS, ZnS, PbSnSe, PbS and Al_2O_3, the last material was used as capping layer in order to obtain clear quantum dot layer of GeS. Moreover, we designed and performing the following diagnostic techniques,

-Michelson interferometer for film thickness measurements.

-System for I-V measurements under fixed temperature using a temperature control system..

-Laser Induced Breakdown Spectroscopy (LIBS) setup for plasma emission spectroscopy, to record a life spectrum during the laser deposition.

-System to test the thin film as optical detector using a diode laser system with fiber beam delivery system.

-System for measuring the resulting thin film distribution on the substrate.

the fabricated GeS layer was examined by atomic force microscope indicates the quantum dots structure of the layer with the domain of 6-8 nm height and less than 100 nm width.

Finally, the introduced here PLD homemade system approved to be a repayable one given reproducible result of the semiconductor layer which produced to be a good candidates for laser detector in different region of the spectrum specially in the IR region.

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