Research on Applications of MOCVD based Automatic Control Circuits

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***Abstract* — With the rapid development of semi-conductor science and related hardware devices, the applications of MOCVD based automatic control system are becoming popular. MOCVD method of preparation of thin films is the metal organic matter after gasification, respectively using carrier gas into the reaction chamber. In indoor produces chemical reaction, reaction products of deposition on the substrate to form a thin film. In this paper, we introduce the applications of MOCVD based automatic control circuits in detail. The simulation result proves the effectiveness of the system.**

Keywords - MOCVD; Automatic Control; Circuit Design and Implementation; Experimental Analysis

I. INTRODUCTION

Thin films of metal oxides are finding a rapidly growing application in advanced materials technology. With the rise of very deep sub-micron and Nano-metric technologies, interconnects are increasingly affecting the overall power consumption, performance, and reliability of the chip. MOCVD method is developed for nearly two hundred and thirty years to a thin film material preparation technology and it belongs to the chemical method which is one of the types of CVD method. MOCVD method of preparation of thin films is the metal organic matter after gasification, respectively using carrier gas into the reaction chamber. In indoor produces chemical reaction, reaction products of deposition on the substrate can form a thin film [1-2]. Our experiments and theoretical analysis proved that if the reasonable design deposition reaction chamber reaction resultant to after cooling of collecting area and at the same time in the preparation of thin film preparation of nanometer powder. The advantages of MOCVD could be summarized as the following parts: (1) Membrane and micro powder elements of both in the form of gas into the reaction chamber by controlling the carrier gas flow rate and switch can easily control it. (2) All the process parameters can be controlled independently with general optimization. (3) Suitable for large area film and batch production. (4) The source supply system including gas source supply and liquid source of supply. Gas source supply is refers to the source gas after decompression, filtering, mass flow controller and pneumatic valve into the reaction chamber while the liquid source supply is refers to the liquid metal organic matter in a specially made bubbler. (5) High deposition rate and good repeatability. (6) Due to source for metal organic deposition temperature decrease. This is done in this work.

More precisely, we introduce an exact approach and a heuristic approach, respectively, aiming at the determination of feasible coding to be used in order to improve the on-chip interconnections [3]. For this purpose, the general idea of existing synthesis methods for reversible circuits work serves as the guideline.

The receiver in the receiving signal with its input level tends to fluctuate. The factors affecting the size of the receiver input level may be the size of the transmitted power and receiver from the transmitters and the change of signal in free space propagation conditions or various noise interference, etc. The receiver input signal range is called its dynamic range[4]. Generally speaking, the receiver back end for signal transmission or processing convenience and the required output signal level is relatively stable, if the receiver gain constant, it will not be able to achieve this requirement so we need to adopt the automatic control technology. Received for receiver, due to the external signal level is not constant, therefore, when receive the weak signal we always hope receiver has a better result. In strong signals, the receiver gain can reduce some, so we can ensure the receiver terminal is a constant level. Usually, the realization of this goal is through the automatic gain control circuit to change the way to implement the amplifier gain. The function of automatic gain control circuit is: when the input signal voltage change is very big, the receiver output voltage constant or unchanged basically. Specifically, when the input signal is very weak, the receiver obtains automatic gain control circuit doesn't work [5]. Automatic gain control circuit by measuring the size of the signal level and comparing with the reference level with fast automatic adjusting the amplifier gain size and control decreases when the input level big gain which input level hours increase control gain to ensure that the receiver intermediate frequency signal output level constant. When the input signal is very strong, the automatic gain control circuit is to control and the gain of the receiver [6-7]. Therefore when receiving signal intensity changes, the receiver output voltage constants power or constant. In recent years, there has been large amount of research interest in tracking control problems for probe-based imaging and Nano-positioning. In the figure 1, we demonstrate the basic concept and the corresponding topology of the MOCVD based chip structure.

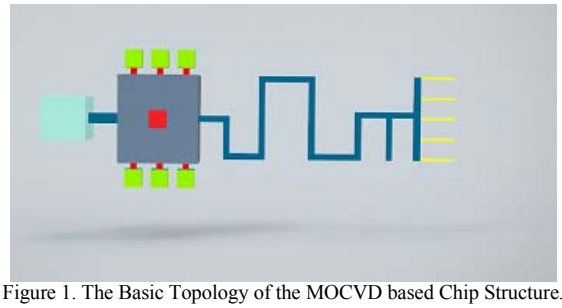

Figure 1. The Basic Topology of the MOCVD based Chip Structure.

Therefore, to conduct more related research and analysis. In this paper, we introduce the applications of MOCVD based automatic control circuits in detail in the following sections. The organization of the paper is scheduled as the follows. In the first section, we provide general introduction to the research. In the second section, we discuss the core technique of the research which could be summarized as the following parts: (1) the introduction of the MOCVD technique and the theoretical analysis; (2) the analysis of the circuit structure and the topology; (3) the combination and the basic concepts of the control system. In the third section, we conduct numerical and experimental simulation on the proposed methodology with general conclusion. In the final part, we summary the research and set up the prospect.

II. THE PROPOSED METHODOLOGY

The Concepts of the MOCVD Technique. Recently, drastic improvements have been achieved on 1.55-μm based VCSELs by finding solutions to the issues mentioned. An essential requirement in the commercialization of the MOCVD technique is the availability of suitable precursors with sufficient volatility and stability, as well as adequate purity and related features which are shown below.

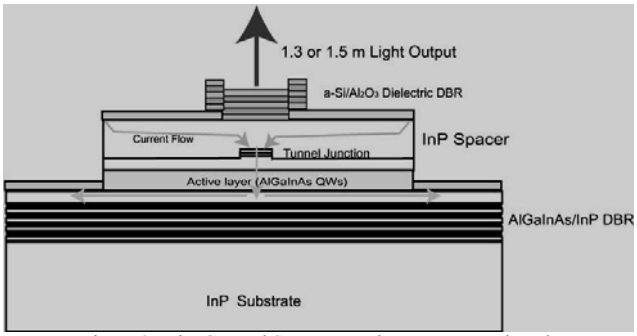

Figure 2. The General Structure and Features Mentioned.

Metal organic chemical vapor deposition to large-scale pure multi-kilogram amounts of precursors and thus precursor synthesis must expand the scale of about three orders of magnitude kg from laboratory scale. To make these characteristics of MOCVD would be able to achieve, we must to strictly control the process parameters and process parameters of MOCVD much more special and it is to control the methods put forward higher and higher requirements, therefore it is necessary to adopt computer automatic control completely. However, the current MOCVD automatic control circuits are imported from abroad which is suffering from the high cost. Because a metal–oxygen bond is already present in metal, the deposition of metal oxides can theoretically be achieved without an added oxidant. However, especially at low deposition temperatures, this can lead to heavy carbon contamination. MOCVD system control is through the computer automatic control and manual control signal switching signal so as to realize the heating system and gas flow and the pneumatic control valve, etc. We design the MOCVD control circuit by using the computer automatic and manual two kinds of control mode, the two kinds of control mode can at any time through the automatic/manual switch to switch. In the figure 3, we show the curve.

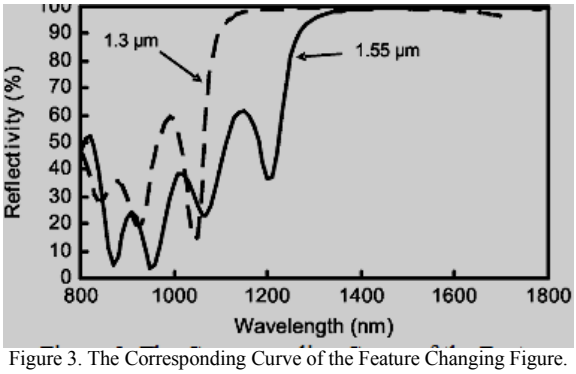

Figure 3. The Corresponding Curve of the Feature Changing Figure.

The Circuit Structure and System Description. The traditional three-phase cage type asynchronous motor autotransformer step-down start relay contactor automatic control system for the following disadvantages: relay contactor is a hardware device, control circuit wiring multifarious, components and contact and contact easy wear and failure rate is high. However, the control function change is not convenient with poor universality or reliability. Automatic and manual switch circuit is to implement the entire system of computer automatic control signals and manual switching. Manual control and automatic computer control signals each way which uses the relay circuit, through the automatic/manual switch to control the control end of the relay so as to realize automatic computer control signals and the manual control switch. Heating system control circuit is responsible for the control of heating component of the whole system. It includes three parts, namely heating and control circuit and digital output circuit, heating circuit responsible for the control of the temperature controller signals into heating components so as to realize the heating parts of heating. Automatic heating control circuit based on the signal and the signal of the manual switch, heating control circuit of the ac power signal and the task is to cut off the power at any time, to stop heating parts supply. Digital output circuit is responsible for the cut off the power supply control signal to the digital output heating control circuit so as to realize the automatic control of the power signal. In the figure 4, we show the Butterworth-Van

Dyke equivalent circuit. The parameters are shown as follows.

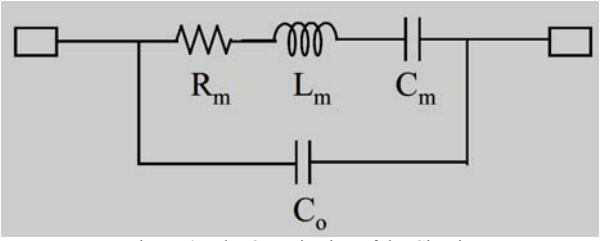

Figure 4. The Organization of the Circuit.

$$R_m = \frac{\pi\eta\varepsilon_r\varepsilon_0}{8K_t^2\rho A w_{aV_a}}, \qquad L_m = \frac{\pi^3 V_a}{8w_r^3\varepsilon_r\varepsilon_0 A K_t^2} \tag{1}$$

$$C_m = \frac{8K_t^2\varepsilon_r\varepsilon_0 A w_r}{\pi^3 V_a}, \qquad C_0 = \varepsilon_0\frac{a}{d} \tag{2}$$

Meter circuit is in charge of the whole system of gas flow control. It includes digital/analog conversion circuit, analog/digital conversion circuit and digital output circuit and flow control circuit four parts. Digital/analog conversion circuit is responsible for the gas flow automatic computer signals into analog signals and passed to the flow control circuit. Analog/digital conversion circuit's mission is to transform from traffic flow control circuit analog signals into digital signal feedback to the computer and digital output circuit is responsible for controlling the state of the flow meter digital signal to the digital output flow control circuit. All the automatic control of flow control circuit implementation of flowmeter signals and manual switch and to communicate directly with the flowmeter. In the table 1, we illustrate the parameter notation for the circuit.

TABLE I THE PARAMETER NOTATION FOR THE SYSTEM

K_t^2	Electromechanical coupling constant	η	Viscousity
$\varepsilon_r\varepsilon_0$	Dielectric constant	A	Area of resonance
V_a	Phase velocity	ρ	Density
w_r	Resonant frequency	N	Harmonic number
w_a	Anti-resonant frequency	d	Thickness of film

The Control System and Theory. In this work, we focus on coding strategies to improve on chip interconnect architectures based on the coding template. Therefore, implementations of encoders and decoders are required that realize the mapping, i.e. that link the most frequently occurring data inputs to patterns with a low Hamming weight. The figure 5 shows the device used for controlling.

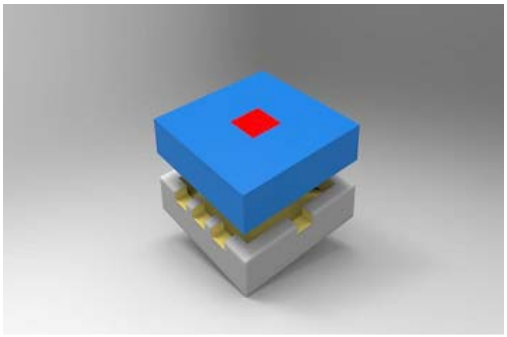

Figure 5. The Device Used for Control System.

Exact synthesis algorithms determine a minimal circuit realization for a given function with respect to a given cost metric. Automatic control system according to the original relay contactor circuit diagram to design the ladder diagram is a simple and practical method. We build the hot wall of low pressure MOCVD system adopts computer automatic and manual two kinds of control mode which can at any time between the two control ways through the automatic/manual switch to switch. Control system includes two parts of hardware and software, hardware including computer, control panel, control circuit and the interface, all kinds of sensors and the corresponding control unit. Computer automatic and manual switch control signal after automatic/manual switch circuit and the control signal control relay which control contactor again by contactor and temperature controller to control the volts heating on the solid state relay signal and through the serial communication between computer and temperature controller circuit of serial communication. However, to ensure the repeatability of MOCVD process we must carry on the strict control of process parameters and the process parameters and the MOCVD system much more special, it is higher and higher demands are proposed to control method. Therefore, it is necessary to adopt computer automatic control completely. Only when necessary to guarantee stability or performance requirements, the communication resources are used. The resulting control strategy aims at striking a balance between periodic sampled-data and event-triggered control. The following formulas formulate the control system description.

$$\frac{d}{dt}x = A^p x + B^p\hat{u} + B^w w \tag{3}$$

In a conventional sampled-data state-feedback setting, the plant is controlled using a controller:

$$\hat{u}(t) = Kx(t_k), \qquad for \qquad t \in (t_k, t_{k+1}] \tag{4}$$

State measurements are transmitted over a communication network and the control values are updated only when certain event-triggering conditions are satisfied. This modifies the controller into:

$$\hat{u}(t) = K\hat{x}(t), \qquad for \qquad t \in \square_+ \tag{5}$$

Gas transport pipeline are all made of stainless steel pipes, pipe joints connected by way of argon arc welding, to keep the reaction chamber of low voltage state, after the

reaction chamber is equipped with vacuum unit and pressure sensor; In order to quickly transform reaction of indoor gas, the gas transport system with bypass; In order to make the reaction gas into the reaction chamber after mixing, in front of the reaction chamber is equipped with the mixing chamber. Heating system is mainly including of diffusion furnace and heating pipes. In order to ensure that the reaction gas in chemical reaction under certain temperature and the temperature of the reaction chamber with a large area uniformity, we three sections of heating for the diffusion furnace; In order to prevent liquid source gas deposits in the pipe, must to heat source of liquid pipelines. MOCVD system control is through the computer automatic control and manual control signal switching signal, so as to realize the heating system, gas flow and the pneumatic control valve, etc. Due to the low reaction chamber pressure, gas diffusion coefficient increased significantly, the film growth rate is strongly dependent on deposition temperature, and is controlled by surface reaction and the correct control of thickness of the film is very good. Other sampling interval implying that no control computations are needed and no new state measurements and control values have to be transmitted shown in the formula 6 with related optimal description.

$$d\left([T]\left|\left[\sum\nolimits_{i}\right]\right.\right)<d\left([T]\left|\left[\sum\nolimits_{j}\right]\right.\right),\quad j=1,2,...,M \tag{6}$$

In the next section, we will test the effectiveness of the proposed methodology.

III. EXPERIMENT AND SIMULATION RESULT

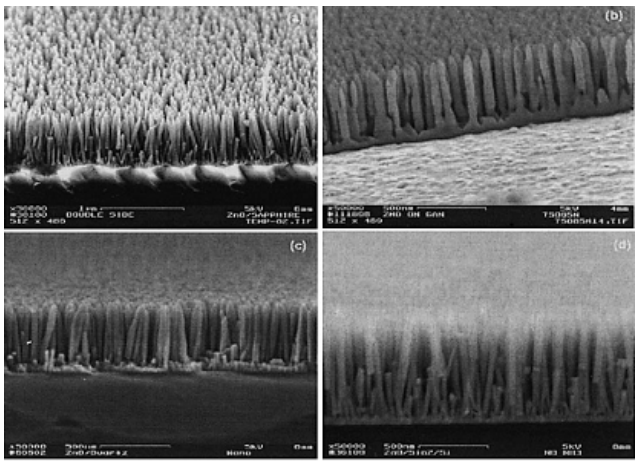

Figure **6.** The Structure of the Generated Nano-tips.

We firstly show the general structure of the generated Nano-tips in the figure 6. These two crystallographic planes have opposite polarity hence has different surface relaxation energies, resulting in a high growth rate along the c-axis. Later, to test the efficiency of the proposed control system, we undertake numerical simulation on the item.

While the event-triggering condition still has a periodic character. The latter aspect leads to several benefits as the event-triggering condition has to be verified only at the periodic sampling times, instead of continuously, which makes it suitable for implementation in standard time-sliced embedded system architectures. Therefore, we illustrate the control simulation in the figure 7.

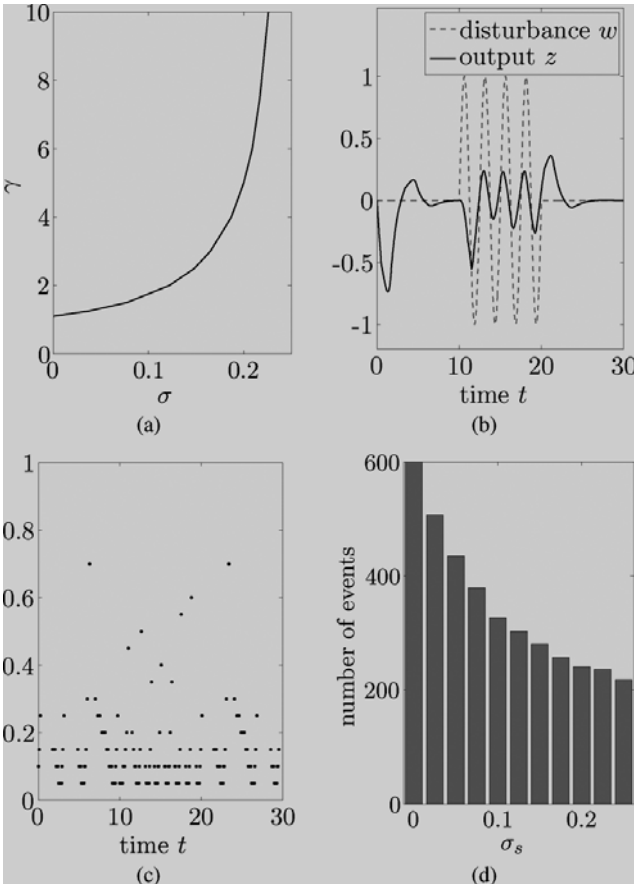

Figure 7. The Control Result for the Proposed System.

IV. CONCLUSION

With the rapid development of semi-conductor science and related hardware devices, the applications of MOCVD based automatic control system are becoming popular. To make these characteristics of MOCVD would be able to achieve, we must to strictly control the process parameters and process parameters of MOCVD much more special and it is to control the methods put forward higher and higher requirements, therefore it is necessary to adopt computer automatic control completely. Therefore, we conduct related research on the topic of the system design and implementation. The experimental result proves the effectiveness of the system. We could conclude that the system is efficient and robust. In the near future, we plan to conduct more related research to polish the current organization pattern of the system.

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