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CLASSIFICATION OF THIN FILM AND ULTRA THIN FILM DEPOSITION METODS

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***Abstract*— Classification of thin film deposition methods - deposition of thin films of semiconductor materials plays a major role in many areas, especially research and development.**

***Keywords*— nanocomposite films, nano-layers, PVD metods, CVD metods, deposition.**

I. Introduction

The variety of specific methods available for depositing nanocomposite films serves as a basis for key research projects, articles and papers in this field. However, a classification has not yet been definitively established in the specific scientific literature. Therefore, this paper suggests the exisitng methods for depositing nanocomposite films be classified under several headings. Thus, the authors discusses both physical and chemical methods, as well as their synergistic effects.

II. Exposition

A. *Producing nano-layers*

- Molecular beam epitaxy;
- Atomic layer deposition;
- Chemical assembly.

B. *Producing nano-layers using electroplating (or galvanic deposition)*

- Supplied- and Non-supplied electroplating;
- Laser-assisted electroplating;
- UV-LIGA Technology

C. *Physical methods: PVD – Physical Vapor Deposition*

Based on evaporation type:

- Resistive evaporation;
- Electron-beam evaporation;
- Induction evaporation;
- Laser beam evaporation
- Vacuum Evaporation (**$P \leq 1{,}33.10^{-1}$ Pa)**
- High Vacuum Thermal Evaporation Method (**$P=1{,}33.10^{-2 \div -4}$ Pa)**
- Ultra High Vacuum Thermal Evaporation Method(**$P > 1{,}33.\ 10^{-5 \div -8}$ Pa)**

Cathodic sputtering and types of sputter deposition :

- Ion beam and plasma sputtering;
- RF sputtering;
- Magnetron sputter deposition;
- X-Ray;
- Gas flow sputtering with additives (to the working gas Ar)

Combined Sputtering & Evaporation process:

- Thermal evaporation accelerated by assymetric cathodic sputtering;
- Thermal evaporation accelerated by alternating sputtering and evaporation;

D. *Chemical methods: CVD - Chemical Vapor Deposition*

- Electrodeposition
- Chemical reduction
- Anodic oxidation
- Electrophoretic deposition
- Gas-phase chemical reduction (reduction of metal halides)
- Gas-phase chemical reduction and chemical treatment
- Laser-assisted thermal deposition
- Reactive sputtered transformation in the gas phase
- Combined evaporation/CVD method – Hybrid Physical-Chemical Vapor Deposition (HPCVD)

E. *Chemical methods: CVD - Chemical Vapor Deposition depending on process parameters – pressure and vacuum*

- Atmospheric CVD in open systems;
- Vacuum CVD ($P \leq 1{,}33.10^{-1}$ Pa ÷ $P \leq 1{,}33.10^{-2}$ Pa) in closed systems.[1]

The table below compares basic thin film deposition methods and summarizes the most characteristic advantages and disadvantages in choosing the best technique for nano layer deposition.

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Fig. 1 Choosing the best technique for nano layer deposition [2]

Deposition Method	Thermal evapo-ration	E-Beam evapo-ration	Cathodic sputtering	PECVD	LPCVD
Materials	Metal or low melt-point materials	Both metal and dielectrics	Both metal and dielectrics	Mainly dielectrics	Mainly dielectrics
Film uniformity	Poor	Poor	Very good	Good	Very good
Purity	Low	High	High	Very high	Very high
Grain size	10~100nm	10~100nm	~10nm	10~100nm	1~100nm
Film density	Poor	Poor	Good	Good	Excellent
Deposition rate	1~20A/s	10~100A/s	Metals: 100A/s; Dielectrics : 1~10A/s	10~100A/s	10~100A/s
Substrate temperature	50~100 °C	50~100 °C	25~200 °C	200~300 °C	600~1200 °C
Directional	Yes	Yes	Some degree	Some degree	Isotropic
Cost	Very high	High	High	Very high	Very high

III. Conclusion

Classification of thin film deposition methods, which is to be used in developing new composite materials, as well as system design processes have been outlined. In addition, different thin film deposition methods have been analysed and compared as the choice of method in the implementation and deposition of a particular layer is based on the problem to be solved and the final outcome. In many cases a variety of synthesis techniques are to be applied or replaced in the dynamics of the technological process in order to achieve the desired performance control and goal.

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