



Synthesis and some Features of Three-Phases Polymer/Metal/Ceramic Multilayers Nanocomposite

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Article history: Received 20 January 2020, Accepted 29 January 2020, Published in October 2020.

Doi: 10.30526/33.4.2521

Abstract

Layer by layer development two features of pulsed laser deposition PLD, with a high kinetic energy and sharp instantaneous deposition rating. Layered films of polymer/metal/ceramic nanocomposites consisting of polystyrene PS(as substrate) , tin Sn and cadmium oxide CdO were deposited by PLD. Structure for layered samples were measured by XRD X ray diffraction, there were appearance of peaks which reflected to formation of new compounds result of reaction between layers. Particles size was calculated using two methods and it give nanoscale. Microstrain was also calculated and exhibited high value (0.01) for sample p/m.

Keywords: PLD, Multilayers, XRD, microstrain, nanoscale.

1.Introduction

Dependent on the features of materials and budget interest , different proficiency have been occupied for the grown of thin films and the multilayers. These comprise TD thermal deposition, SD sputter deposit, CVD chemical vapor deposit, and PLD pulse laser deposit. Thermal deposit is the eldest and the utmost capable technique to growth thin films. Compared with these approaches, PLD has a singular ability to product high types of thin films of materials of several types [1]. PLD process involves concentrating an intensity laser pulse on the target surface, and transferring materials of target in the manner of some a phases of volatile (gas or plasma). Clear benefits of PLD contain its easiness of using, ever since the laser was completely de coupled from the grown chamber, and capability to reserve the stoichiometry of materials compound in optimal specifications. Latter build PLD is a



primary choice of growing complicated materials like oxides of transition metal [2-4]. In pulse laser deposit, moreover knowing by way of laser MBE when grown is measured and checked in a layer - layer way, a laser pulse with extreme and small are strikes a target and ablating the material beginning target. When the pulse of laser is absorbs in the surface level of the target, energy of electromagnetic is directly transformed into exciting the electrons in develop of Plasmon and un-bound of electrons. Electrons have been excited after then transmission their belong energy to lattice through electron - phonon e – p pair inside a few of picoseconds. Composite nanostructured materials including of polymers and metals have a wide range of requests In thin film deposition, clusters of metal can be growth by atoms agglomeration which deposit on the substrate surface, known Vollmer Weber island growth [5-7]. Size of cluster and shape are well-defined by the growth mechanisms on the surface of substrate, which powerfully depend on the preparation conditions and on diffusion of the metal in the matrix and top its surface. The grown mechanisms conducting to the detected nanostructures have been investigated in these concerns, focusing especial on implanting effects, dissimilarities in metal diffusion and reactivity with the polymer. Further, the clusters are forming on the substrate surface because of implantation effects. Operation of the PLD comprise concentrating an intense of pulse laser top on the surface level of a target, and take out materials of target in the forming of specific volatile phases, a gas or a plasma. Separate benefits of PLD comprise its simplicity of using, pulsed laser deposition PLD is the ability to produce high energy source of particles, allowing the grown of high quality film at moderately low substrate temperature. Ultra - high instants of deposited rating and the high of energy of kinetic PLD that production the greatest critical roles. The enhanced growth, in specific for the first numerous monolayers, providing great chance to design conterfiate structures of thin films which have hopeful properties[8-10].

Synthesis of multilayers from polymer, metal and metal oxide are goal of the paper.

2.Materials and Methods

In this study, Polystyrene employed was provided by Polymer Chemical Company , HIMEDIA, Chloroform was used as a solvent for PS, tin Sn powder metal from (Riedel De-Hain Company) and cadimeum oxide CdO provided from(Reagim company). Thin films of pure polystyrene PS were synthetized by applying solution - casting technique, which was used as substrate . PS was dissolved in using magnetic stirrer of hot plate at 70⁰C for 2hr to obtain solution with homogeneously. For extreme dispersing the solution was furthermore stirring for 2hrs by protection the temperature was constant. Thin films were provided by draining the solution on a washed optical plane plate of glass. The whole system was allowable to evaporat at room temperature RT in dust at liberty chamber and after that completing evaporation, the film was separate from the surface of glass. To preparation the targets, tin powder metal and cadimeum oxide ceramic powder, as individual, of 4gm weight was pressed under 4-9 ton for around 0.5-1m to form the target with 1.5cm diameter and 0.25-0.3cm thickness. Target must be dense as a disk to get a surface with homogenously for depositing same mass of material at all pulses process when altering the laser local beam. Layered films of polymer/metal/ceramic nanocomposites consisting of polysrtyrene (as substrate) , tin and cademium oxide were deposited by pulsed laser deposition (PLD) KrF excimer. **Figure1.** Schematic diagram of the system of the active medium is an Nd-YAG

crystal and with a fundamental wavelength of 1064 nm, pulse duration of 10 ns and number of pulses 100 was use and laser energy of 200 mJ at room temperature of vacuum chamber made of quartz and the target is mounted inside the chamber on a stainless steel substrate with a base pressure of about 5–6 mbar chamber. Laser component was out of chamber room , and fixing for beam of laser on the surface level of the target was achieved by applying an optically lens of focally length 20cm. This by alternatively switching the target from Sn to CdO. On the smooth polymer layers, the metal and ceramic grew in Vollmer-Weber Island growth leading for thin films of Sn and CdO to layered PS/Sn/CdO. Technique of deposition (PLD) was repeated carried out with change the laying. The structure of the layered samples were studied by X-ray diffraction (XRD) (SHIMADZU JAPAN, XRD – 6000) with Cu K α radiation ($\lambda = 1.542 \text{ \AA}$) was used.

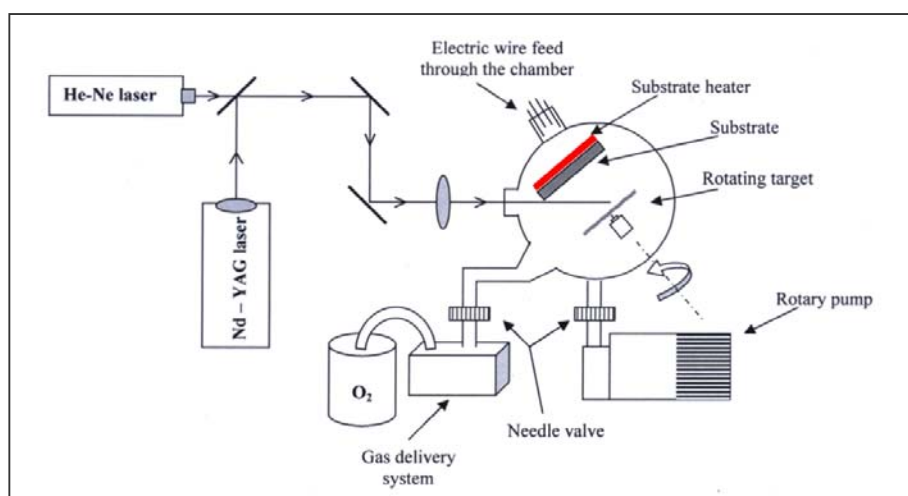
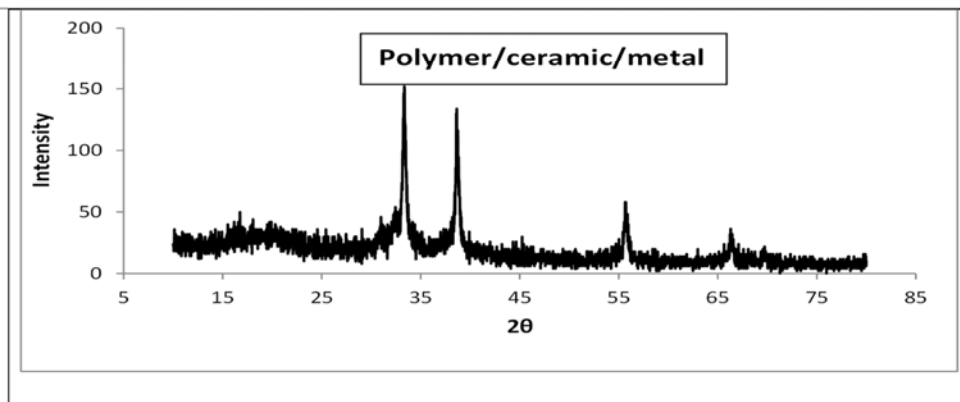
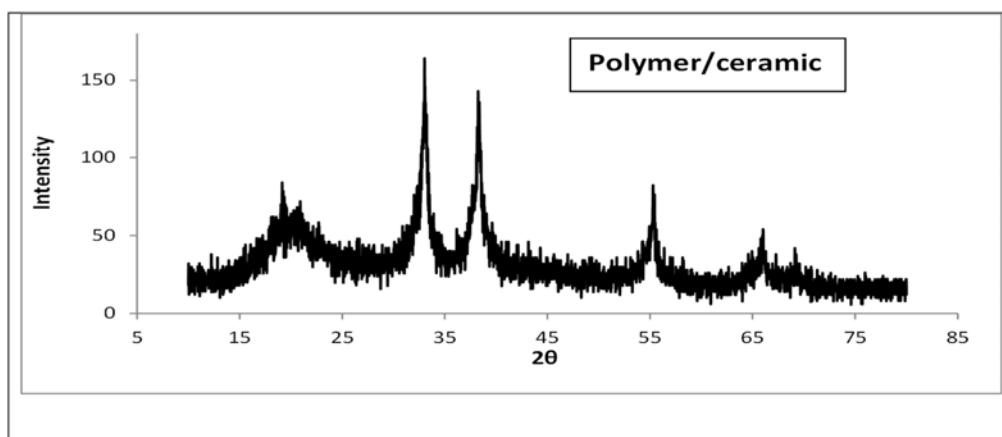
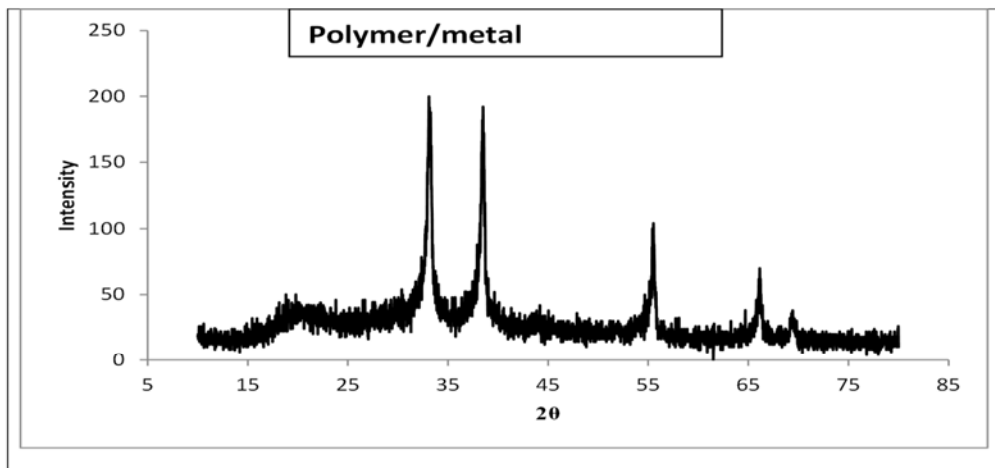


Figure 1. Schematic diagram of the system of this work.

3.Results and Discussion

The obtained structure was shown in the measured for X- ray diffractions and explained in **Figure 2**, it was note there were peaks presentation obviously, In prepared sample polystyrene pure the nature of XRD are amorphously and there was a peak at $2\Theta=20$. Sample of polymer/metal (p/m) with peaks at $2\Theta= 30,32,43.8$ and 64.5 for plans (200), (101), (220) and (321) respectively led to tin metal layer precipitated on polymer polystyrene using pulsed laser deposition technique. Peaks for sample polymer/ceramic (p/c) at angles $2\Theta=33, 38, 55$ and 66 reflected from plans (111), (200), (220) and (311) referred to cadmium oxide (CdO) layer which precipitated on polymer polystyrene using same technique. New compounds appeared obviously like Cd_2SnO_4 at a round peak $2\Theta= 32.6,57$ with diffracted (311), Sn_3O_4 at peak $2\Theta= 32.8$, of plane (003), SnO_2 at angle $2\Theta= 65.7, 26.5$ and 37.7 reflected from plans (301), (110) and (200).



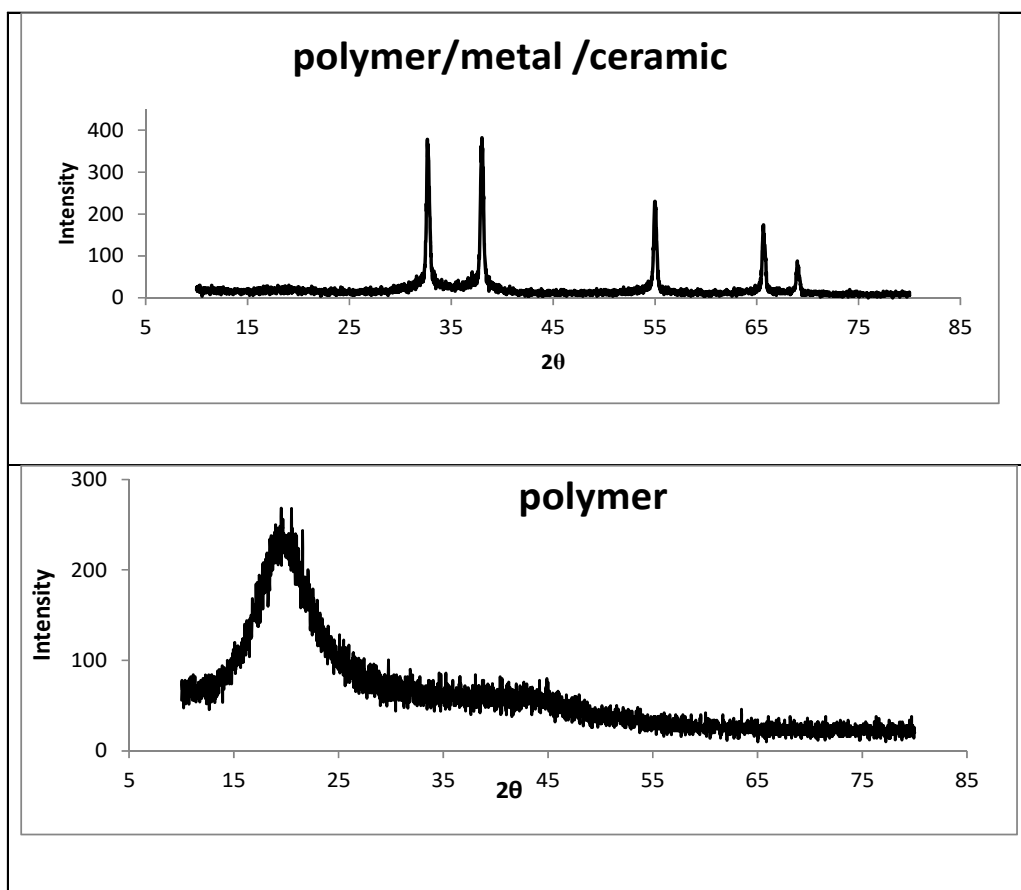


Figure 2. X- ray diffraction spectra for synthesized samples.

The average nano crystalline size was calculated using two methods. Firstly, Debye-Scherrer's formula

$$D = \frac{k\lambda}{\beta_{hkl} \cos\theta} \quad (1)$$

where D = crystalline size, K = shape factor (0.9), and λ = wavelength of $Cu\alpha$ radiation.

Secondly, Williamson-Hall (W-H) equation.

$$\beta_{hkl} \cos\theta = \frac{k\lambda}{D} + 4\epsilon \sin\theta \quad (2)$$

ϵ is microstrain, figure 3 show plot was drawn of $4\epsilon \sin\theta$ along the x-axis and $\beta_{hkl} \cos\theta$ beside with y-axis.

Table 1. revealed all the precipitated layered samples in range of nanoparticles.

Sample Symbol	Layers Order	Particle size(nm) Method 1	Particles size(nm) Method 2	Micro strain	Crystal Structural	a (Å)	c (Å)	Cell vol (Å ³)
P1	P	-	-	-	-	-	-	-
P2	p/m/c	26.3913	17.4166	0.00215	cubic	8.07685	-	526.896
P3	p/c	15.3645	9.1437	0.00475	cubic	4.69727	-	103.642
P4	p/m	17.3625	20.9000	0.01000	tetragonal	4.35905	3.18426	60.510
P5	p/c/m	21.7647	19.7702	0.000675	tetragonal	5.66378	2.89525	92.875

Aberrations from ideal crystallinity, like finite size of crystallite and strain (at the atomic scale) conduct to broadening of the lines diffraction. Sources of line comprised, broadening of instrument, broadening of Crystallite Size and Strain Broadening, Elongated Defects for Stacking Faults . Anti - phase Boundaries. Elongated defects interrupted the arrangement of crystal atomic, typically along with 2D planes. These defects efficiently terminated a crystallographically domain ordered of the crystals. Uniform strain reasons to expand/contract unit cell in an isotropic direction[9-13]. This led to alter in a unit cell parameters and modification of the peaks. There was no broadening related to this kind of strain. Non-uniform strain guide to systematic shifts of the atoms from their ideal of positions and to peaks broaden. This kind of strain point defects (vacancies, site-disorder, etc). In method 2 W-H equation which included strain effect and results of the particle size for sample p/m showing a value higher (20.9 nm) with micro strain (0.01) than that calculated (17.3 nm) in method 1 of Debye-Scherrer's formula. Lattice parameters gave slightly deviation from individual metal tin and ceramic cadmium oxide, rather than, samples p/c/m and p/m/c that gave obviously deviation from pure which led to the reaction between two layers metal and ceramic

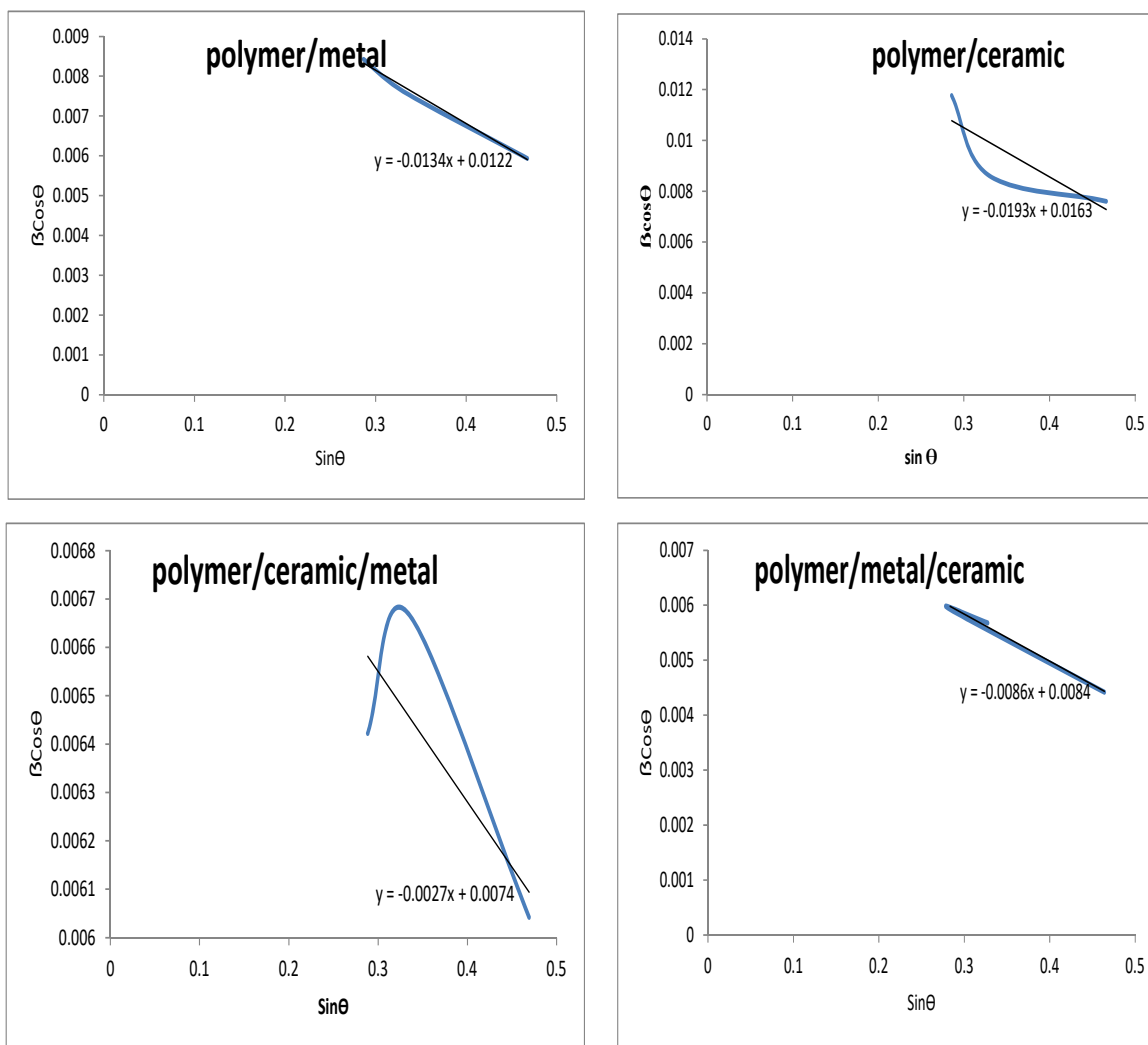


Figure 3. Plot of William – Hall equation for synthesized nanocomposites.

4. Conclusion

Layer by layer growing has two characteristic marks of PLD Pulse laser deposit, was a influential process to develop thin films and multilayers of difficult materials such as oxides of metal. In this state, utmost named benefits of PLD is easiness of preserving the stoichiometry the target of material. Layered films of polymer/metal/ceramic nanocomposites consisting of polystyrene (as substrate) , tin and cadmium oxide were deposited by pulsed laser deposition (PLD). Structure of layered prepared samples were studied by X-ray diffraction (XRD), there are presence of peaks which that reflected creation of new compounds result of reaction between layers. Particles size was calculated applying two methods and gave nanoscale. PLD can meaningfully improving the grown of thin films as multilayers. Micro strain also calculated and exhibited high vale for sample p/m.

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