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CTAB and acetic acid effect in the nanocrystallite growth of spray deposited CdO thin films

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ABSTRACT

CdO thin films were deposited on glass substrates from cadmium acetate dihydrate along with precursor additives, acetic acid and CTAB using home built splay pyrolysis unit. XRD studies imply that the CdO thin films to be preferably oriented in the (1 1 1) plane. The Williamson–Hall plot indicates the presence of microstrain, especially high with acetic acid additive. Surface morphology was found to be closely packed spherical crystallite with precursor additives. Optical studies reveal a considerable change in the transmittance and band gap. Peak position is shifted in the Raman spectra, due to precursor additives.

1. Introduction

Research on metal oxide thin films has been a noteworthy nowadays. Among many metal oxides, cadmium oxide (CdO) is an n-type semiconductor with a band gap of 2.50 eV at ambient temperature [1] and has gained greater recognition due to its outstanding properties such as greater electron mobility [2] and high optical transparency [3]. The capability of CdO thin film electrodes to withstand nearly 1000 cycles of cyclic voltammetry without decrease in the specific capacitance makes it viable to be used as an electrochemical capacitor [4].

For the deposition of cadmium oxide thin film, methods such as sol–gel [5], DC magnetron sputtering [6], thermal evaporation [7], spray pyrolysis [8,9], e-beam evaporation [10] and chemical vapor

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Table 1
pH of acetic acid and critical micelle concentration (CMC) of CTAB.

Acid additive in precursor solution		Surfactant additive in precursor solution
Volume of acetic acid (mL)	pH	[a]CMC value of CTAB (M)
0	7.32	–
0.5 (C_1)	4.27	0.001 (CS_1)
1 (C_2)	3.98	0.002 (CS_2)
2 (C_3)	3.69	0.003 (CS_3)
3 (C_4)	3.52	0.004 (CS_4)

[a] CMC – Critical Micelle Concentration.

Table 2
Optimized deposition condition of prepared CdO thin films.

Spray parameter	Value
Precursor salt concentration	0.05 M
Solvent volume	50 mL
Substrate–nozzle distance	30 cm
Spray gun angle	45°
Deposition temperature	250 ± 1 °C
Carrier gas pressure	2 kg/cm^2
Spraying time	5 s
Successive spray interval	75 s

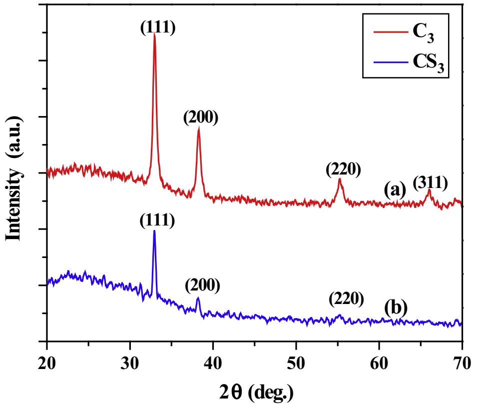

Fig. 1. XRD patterns of CdO thin films with precursor additives acetic acid (C_3) and CTAB (CS_3).

deposition [11] are used. Among these, spray pyrolysis method is cost effective and simple in obtaining different nanostructured thin films [4,9,12–19]. Spray pyrolysis is a process in which a thin film is deposited by spraying a precursor solution on a pre-heated substrate, where the constituent reacts to form the desired chemical compound. The chemical reactants are screened such that the products other than the required compound are volatile at the deposition temperature.

Colak et al. [20] reported the characterization of chemically sprayed CdO films on borate and phosphate glass substrates. Raj et al. [21] outlined the impact of n-heptane as surfactant in the formation of CdO nanowires through microwave combustion. Dakhel [22] enumerated the effect of thermal annealing in different gas atmospheres on the structural, optical and electrical properties of Li-doped CdO nanocrystalline films. Vimalkumar et al. [23] detailed the effect of precursor medium on structural, electrical and optical properties of sprayed polycrystalline ZnO thin films.