



Studies on sprayed lanthanum sulphide (La_2S_3) thin films from non-aqueous medium

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Abstract

Thin films of lanthanum sulphide (La_2S_3) have been deposited onto glass substrates by spray pyrolysis technique from non-aqueous (methanol) medium. The structural, morphological, optical, dielectric, electric and thermoemf properties were studied. The films were polycrystalline with an irregular shaped particles present over the porous structure within a fibrous network structure. The optical band gap was estimated to be 2.50 eV. The dielectric properties were measured in the range 100 Hz–1 MHz. The electrical resistivity was of the order of 10^4 to $10^5 \Omega \text{ cm}$. Thermoemf study revealed that the La_2S_3 films exhibit p-type electrical conductivity.

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1. Introduction

Lanthanum sulphide has many applications in rare earth alloy preparation, superconductivity, magnetic cooling, magnetic thin films, photovoltaic and thermoelectric devices, etc. Several research groups have prepared lanthanum sulphide thin films with a number of physical and chemical techniques. Berkley et al. [1]

have prepared lanthanum sulphide (LaS) superconducting thin films by vapor deposition method. Ikeda et al. have prepared lanthanum sulphide (LaS_x) films by direct combination of La and S between 600 and 900 °C in sealed quartz capsules, under an argon atmosphere in an induction furnace [2]. $\text{La}_{3-x}\text{S}_4$ thin films were prepared by vacuum deposition on optically polished quartz, single crystal quartz plates, mica glass, and pyroceramic substrates by Melnikova et al. [3]. Westerholt et al. [4] have prepared polycrystalline $\text{La}_{3-x}\text{S}_4$ by direct reaction of the elements in closed quartz tubes at 600 °C. Lanthanum

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chalcogenide films were prepared by vapor deposition in sealed Mo containers [5]. Similarly, Lanthanum sulphide samples were prepared through reaction of hydrogen sulphide with lanthanum tri {bis(trimethylsilyl)amide} [6]. Kumta et al. have chemically synthesized cubic lanthanum sulphide ($\gamma\text{-La}_2\text{S}_3$) films, and used in infrared transmitting material for window applications [7].

In earlier report, we have prepared lanthanum sulphide thin films with mixed phases ($\text{LaS}_{1.94}$, La_2S_3 and La_5S_7) using aqueous solvent by spray pyrolysis technique [8]. The formation of mixed phases could be due to the formation of lanthanum hydroxide in aqueous medium. To overcome this difficulty, in the present study, a non-aqueous methanol solvent was used and lanthanum sulphide (La_2S_3) films are formed, and their properties have been reported.

2. Experimental details

Lanthanum sulphide (La_2S_3) thin films were deposited using spray pyrolysis technique. The schematic diagram of the experimental setup is shown in Fig. 1. The deposition conditions were optimized in order to obtain reproducible and good quality thin films. The quality of the films was determined on the basis of its adhesion, crystallinity, thickness and composition. Purified compressed air at pressure of $5 \times 10^4 \text{ N m}^{-2}$ was used as a carrier gas. Lanthanum ($\text{LaCl}_3 \cdot 7\text{H}_2\text{O}$) and thioacetamide ($\text{CH}_3\text{-CS-NH}_2$) were dissolved in methanol. From these, equimolar solutions were mixed in volume ratio of $\text{LaCl}_3\text{:CH}_3\text{CSNH}_2$ as 2:3. The effective area of glass substrate was $75 \text{ mm} \times 25 \text{ mm}$. The films were yellow in appearance and strongly adherent to glass substrates.

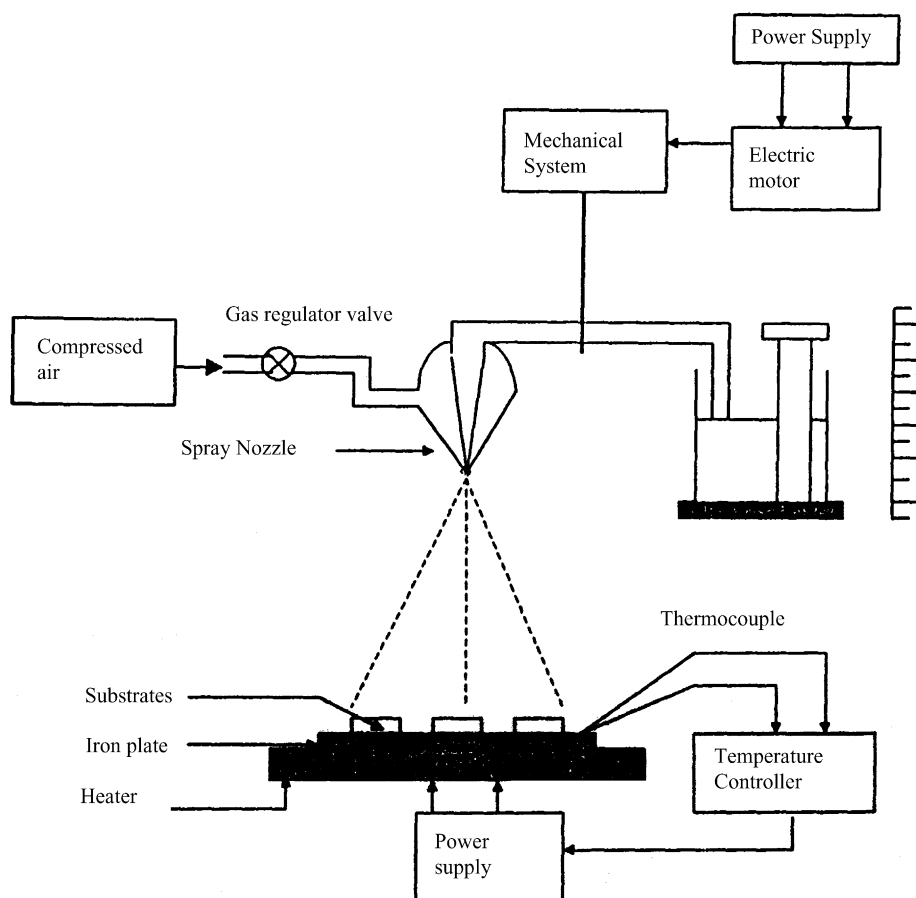


Fig. 1. Schematic setup for spray pyrolysis deposition.

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