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The role of Ag layer in the optical properties of PN junction thin films

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CdS/PbS and CdS/PbS capped with Ag thin layer thin films were organized by chemical bath deposition technique. The effect of silver layer on the optical properties (absorption and direct and indirect band gap) were investigated. It was observed from the absorption spectra of the thin films that the silver layer that deposited on the surface of film has a very important influence on the location of the absorption peak as well as the amount of the energy gap. The band gaps were found in the range 1.75 to 2.38 eV.

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1. Introduction

Thin films have piqued the interest of scientists and engineers in recent years because of their unusual electrical, optical, magnetic, and catalytic capabilities [1]. For the deposition of films, a variety of processes have been proposed, including spin coating, drop casting, chemical bath deposition (CBD), and others [2,3]. CBD method is considered one of the most important chemical methods for preparing many type of thin films from metals and semiconductor because of what is characterized by this method in terms of ease of preparation, availability of equipment as well as low cost[4-7]. Thin films have at present been used in semiconductors devices, wireless communication, telecommunication, integrated circuit, rectifier, transistor, solar cell, light-emitting diode, photoconductor, light crystal display [8,9].

In recent years, thin-films solar cells have appeared as a highly hopeful type of renewable energy source, owing to their low cost of development and theoretically high power conversion efficiency [10].

A wide diversity of semiconductors have been used in thin-films solar-cell applications over the years. While there were a few promising options, CdS and PbS stood out as particularly promising because of their prospective capacity to increase solar energy conversion from the ultraviolet (UV) to near infrared (NIR) area. Furthermore, the richness of sulfur in the earth's crust is significantly larger than that of selenium, making these compounds more cost-effective and ensuring a reliable source for a longer period of time than selenium. CdS and PbS semiconductors materials have an acceptable band gap in the range of 2.28–2.45 eV and 0.41–1.16 eV, respectively, and are therefore ideal for use in electronic devices [11-14]

The aim of this present work is to prepare and fabricate double and triple layers nanoscale thin films by a chemical bath deposition process on glass substrates and study the effect of Ag coating on optical propeerties of CdS/PbS thin films

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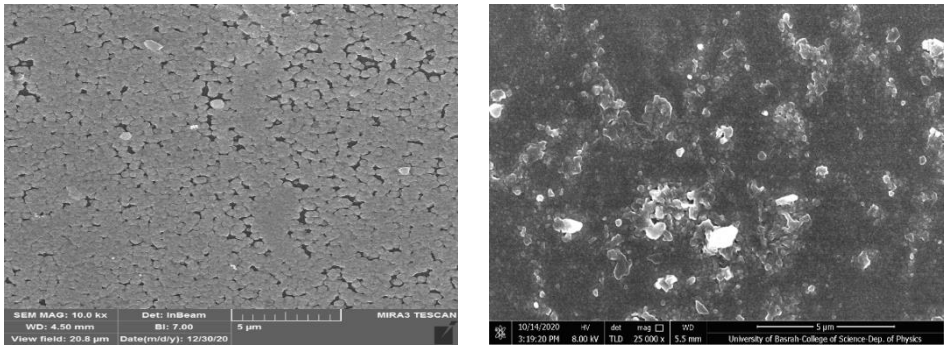
2. Experimental

CdS and PbS thin films was fabricated according to our work [15,16]. PbS thin flim was deposited on the surface of CdS film by CBD method to prepare CdS/PbS Heterojunction double layer thin film. At this point, the two-layer film was aided to completely dry before it was submerged in a silver ion solution that was made up of silver nitrate, trisodiumcitrate, and water. For one hour, the temperature of the bath stayed at 50 °C. The films that were put on were all the same thickness and had great adhesion to the surface.

3. Results and discussions

Fig. 1a displays the FESEM picture of the PbS thin-film, and it is shown in that picture. Stone-shaped particles were all over the surface of the film. The film doesn't show any cracks or holes. In Fig. 1b, you can see the SEM image of the CdS films that was made. The image from the FESEM shows that the surface of the film was flat and had spherical shaped grains. Surface: The grains were all the same size. The thin sheets don't have any cracks or holes.



(a) *(b)*

Fig. 1. (a) PbS and (b) CdS thin films FESEM micrographs.

Absorption measurement between 400 and 1100 nm was made. As for the PbS/CdS film, the absorption is clear in the 700 nm range and gradually weakens with increasing the wavelength, so it is completely transmitted for wavelengths above 950 nm. The absorption spectrum of the PbS/CdS/Ag thin film prove a noteworthy absorption in the visible zone and a great transmission in the infrared region, as exposed in Fig. 2

Tauc plots were used to measure the direct energy gap (Eg) of the CdS/PbS and CdS/PbS/Ag films, as depicted in Figure 3. In spite of its decent band gap of 2.04 eV, the PbS/CdS film's band gap increased to 2.38 eV with the addition of an Ag thin layer to its surface.

On the basis of hv, the indirect gaps of the PbS/CdS and PbS/CdS/Ag thin films were calculated (see Fig. 4). From the figure, indirect bandgaps have been meant to interrupt the best fit of line in the horizontal direction. For PbS/CdS and PbS/CdS/Ag, it was discovered that the indirect bandgap values were 1.75 and 2 eV, respectively.

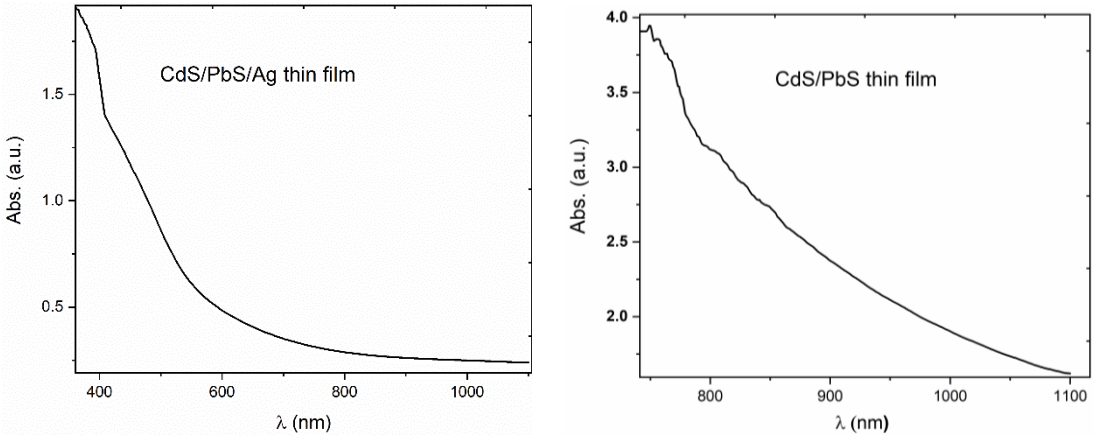


Fig. 2. The spectrum of absorption of CdS/PbS and CdS/PbS/ films.

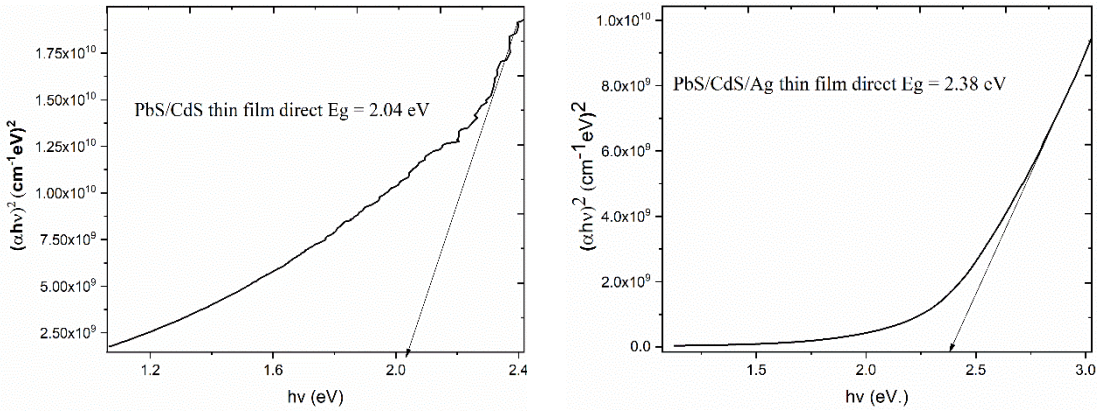


Fig. 3. Direct Band gaps of CdS/PbS and CdS/PbS/Ag films.

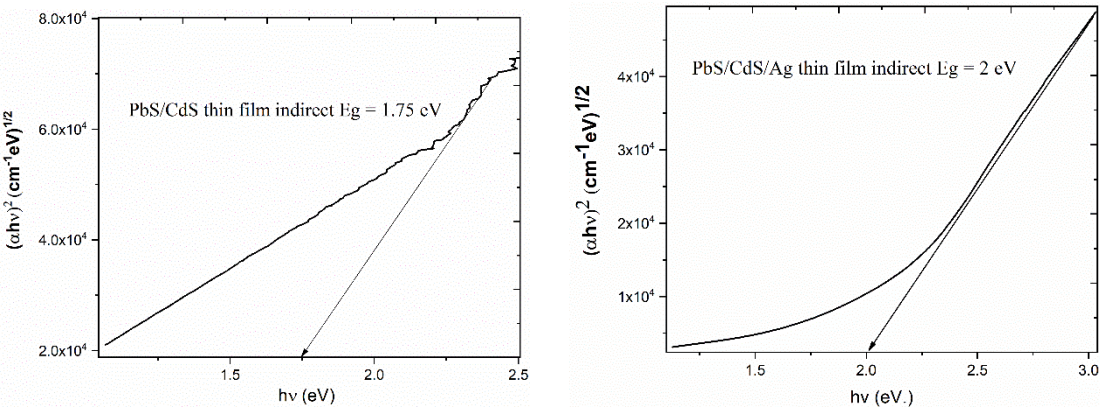


Fig. 4. Indirect Band gaps of CdS/PbS and CdS/PbS/Ag films.

4. Conclusion

CdS/PbS and CdS/PbS/Ag thin films were deposited using the CBD process, which is described in detail below. We evaluated the effect of an Ag layer on the optical characteristics of a CdS/PbS thin film, as well as the amount of direct and indirect bandgaps present in the film. The

distinctive absorption peak for thin films is visible in the UV/VIS spectra, with wavelengths spanning from 400 to 900 nm. There was a noticeable shift in the peak location noted.

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