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Characterisation of Lead Sulphide (PbS) Films by Optical and Scanning Electron Microscopies

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Lead sulphide (PbS) films are essential materials for developing optoelectronic devices such as infrared detectors and photovoltaic cells. The main advantage of PbS is the possibility to modify its band-gap easily using various approaches, e.g. physical and chemical techniques [1-2]. A widely used method for preparing PbS films is the Chemical Bath Deposition (CBD). It is a highly versatile technique, which allows preparing thin films with different thicknesses at relatively low temperatures and cost [2-3].

Herein, CBD was used to grow PbS films onto SiO_2 glass substrate in the following way. Firstly, a volume of 50 mL of deionised water was placed in a beaker and heated up to 50°C. Then 5 mL of Lead Acetate (Sigma-Aldrich, 99.9%) solution at 0.5 M was added, following 4 mL of a Polyethylenimine (Sigma-Aldrich, 98%) solution (7% volume) as a complexing agent. Finally, 6 mL of 1M Thiourea (Sigma-Aldrich, ≥98%) and 5 mL of 1M NaOH solutions (Sigma-Aldrich, 32%) were added. The SiO2 glass substrate was submerged into the above solution while keeping the temperature constant at 50 °C for 20 min. The film was characterised using an Optical Microscope Labomed® MET400 and the FE JEOL-7401F Scanning Electron Microscopy.

Figures 1a-c show the microstructural characterisation of the PbS film by optical microscopy at different magnifications. The microstructure features a homogeneous bright grey area associated with typical characteristics of PbS films, which presents some irregularities, possibly due to contaminants, depicted by the dark areas. Figure 1d, shows the PbS film specimen as-deposited, which shows a characteristic dark brown colour. Figure 2 shows the SEI image of the PbS surface. The figure also shows the EDS qualitative analyses, which gives the chemical composition of the PbS film. The analysis suggested that the imperfections corresponded to deposits of residual organic material used in the CBD technique. On the other hand, there is a presence of Pb and S elements in the flat regions of the specimen. The latest would suggest that the technique produced a film of PbS [4].

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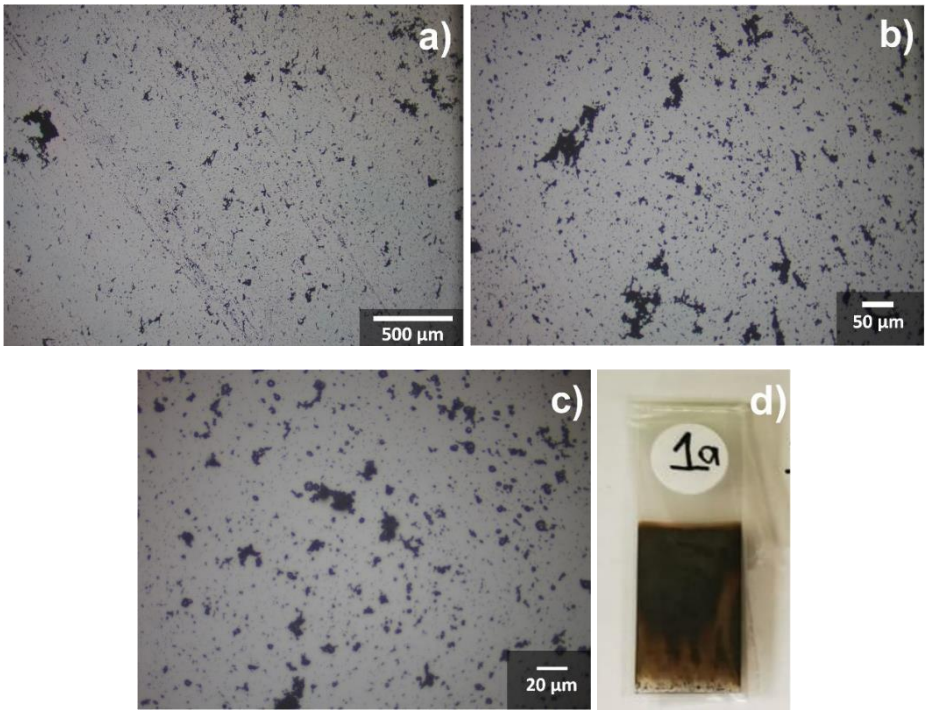

Figure 1. Optical microscope images from the surface of the PbS film at a) X50; b) X200; and c) X500. d) the studied specimen of PbS film as deposited.

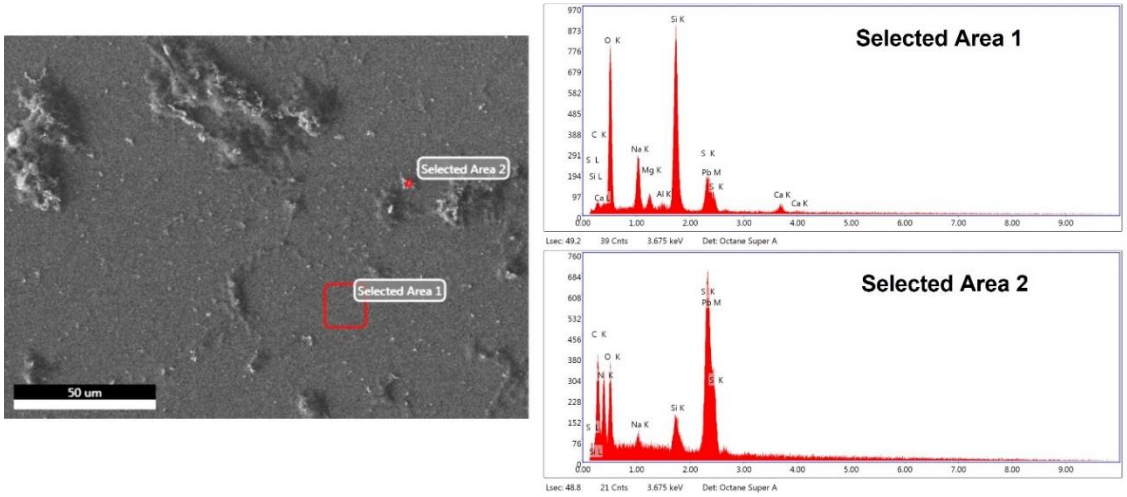

Figure 2. SEI image of the PbS film deposited onto SiO_2 glass substrate, and EDS analyses in two areas of the specimen.

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