

Investigation of transition metal molybdenum ternary chalcogenide thin films (MoX_2) for photoelectrochemical

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ABSTRACT –Through the performance of the PEC systems in power conversation, it may be possible to build affordable photovoltaic panels. The main reasons is to find the right alternative materials for the conversion of solar energy. therefore, this research will focus primarily on using electrodeposition techniques to investigate transition thin film molybdenum. This molybdenum chalcogenide can be used for photovoltaic conversion in thin films as ternary materials for solar cells.

1. INTRODUCTION

The primary source of energy such as fossil fuels are steadily declining even as the demand for energy is growing globally. Given the increasing demand for energy, renewable sources of energy should be produced [1].

Earth's upper atmosphere receives approximately 174,000 terawatts (TW) of energy from the sun and 94,800 TW are available on earth's surface after losses that can be used for energy used. Currently, about 18TW of world energy demand is anticipated, a small fraction of the energy produced on the earth's surface. By 2030, to sustain the current standard of living, energy demand is expected to grow by about 30% worldwide [2]. Solar cell thus regarded as the highly promising ways of meeting global energy needs because solar energy is the cheapest, cleanest, easiest, and most usable energy source for future renewable and sustainable energy technologies. Thin films photovoltaic has becoming a potential alternative for generating large-scale power [3].

In recent decades, semiconductors have achieved great interest due to their exclusive optical, electrical, and also catalytic properties making them the highly appropriate materials that can be used for thin films and photovoltaic [4]. In addition, photoelectrochemical (PEC) solar cells can also be used in many optoelectronic applications due to large direct optical band gaps with great optical and electrical properties that made it suitable for the development of optoelectronic devices [5]. In addition, there is a increasing enthusiasm for multinary metal chalcogenide due to the search of new thin band gap semiconductors and the possibility of adapting the optical and electrical properties over a wide range [6].

2. METHODOLOGY

2.1 Preparation of substrates

Indium-tin-oxide (ITO) coated conducting glass substrates will be used to deposit the molybdenum chalcogenide thin films. The ITO glass substrate will be cut into small with 15 x 25 mm size and it will be cut by using diamond cutter and it will be dipped into 50% diluted hydrochloric acid (HCL) a few seconds before electrodeposition process takes place.

2.2 Electrolyte preparation

There will be three different solution which are consist of different elements. The first solution will consist of 8.1 grams of molybdic acid powder in ammonia solution, second solution consist of 5.55 grams selenium dioxide powder in distilled water and lastly 7.97 grams of tellurium dioxide in distilled water.

2.3 Cyclic Voltammetry measurements

Cyclic voltammetry have been done between two possible limits for the solutions that were prepared to check the portable potentials appropriate for thin films deposition. The current and voltage profiles will be monitored by using electrochemical Analysis System Software (PAR Versa Studio 2.0) and it also will be used to control the deposition process.

2.4 Electrodeposition thin films

ITO glass substrate were used as a working electrode and graphite was used as a counter electrode meanwhile saturated calomel electrode with silver or silver chloride will be used as a reference electrode. The released ion will be attracted and deposited perpendicular to the surface of substrate. The potential of the working electrode were measured via saturated calomel electrode.

3. RESULTS AND DISCUSSION

3.1 SEM

The surface morphology of MoSe thin films deposited at different potentials from the electrolyte are shown in figure 1. The deposited has a homogenous and compact layer structure with a randomly distributed

small porosity over the surface when the potential -0.8 was applied. It is well covered without any cracks or pinholes on the copper substrate. However, when the higher magnification is applied, the characteristics flakes-like structure is visible. In comparison, the coating which was applied at -1.0 did not very well bind to the substrate. Some parts of the deposited peeled off the copper substrate.

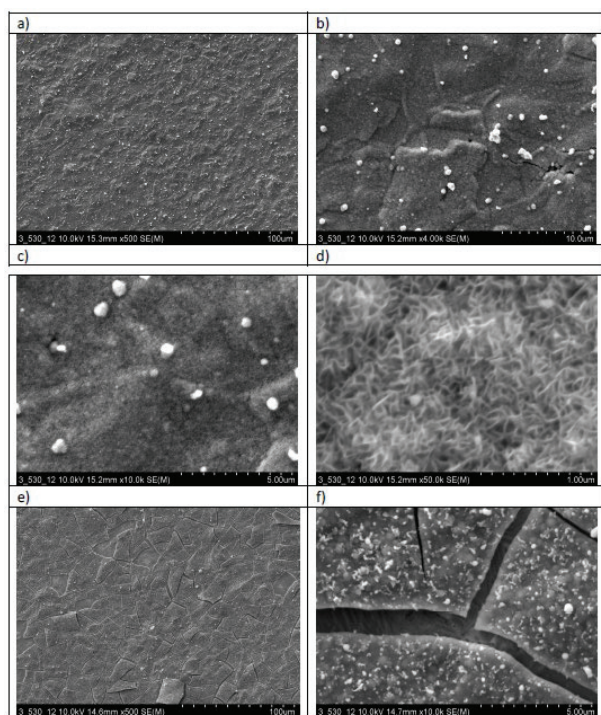


Figure 1 surface morphology of deposited layers obtained using Cu substrate applied at potentials: a-d) -0.8V, e-f) -1.0 V

3.2 XRD

Examples of the deposited coatings x-ray diffraction patterns are shown in figure 2. Small peaks appeared indicating the presence of a mixture of MoSe_2 and Mo_3Se_4 phases for samples deposited at -0.8 and -0.9 V potential. In addition, copper substrates is associated with the most intensive peaks. Furthermore, examination of deposited coating at potential -1.0 V does not show any crystalline phases. The deposited material can be presumed to be totally amorphous.

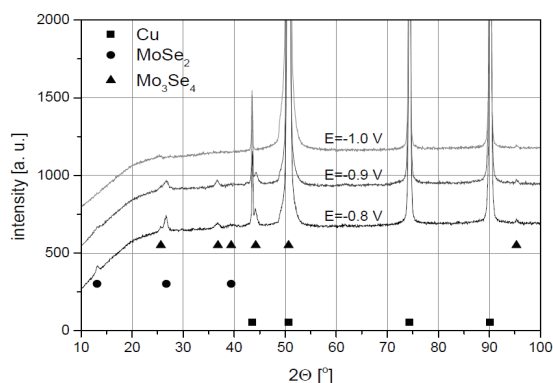


Figure 2 XRD patterns of film deposited at different potentials from electrolyte

4. CONCLUSIONS

The morphology and quality of the coatings strongly depends from their composition. The films showed black in colour, homogenous and compact morphology with characteristics flakes like structure noticeable in higher magnification. Besides, the optical band gap of the materials should be between 1.0 and 2.0 eV to make this material suitable to use as PEC solar cells. Furthermore, the electrodeposited thin films must be well coated, compact and also homogenous for the applications of solar cells.

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