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Study of the Growth of Magnesium Oxide Thin Films Using X-Ray Diffraction Technique: Mini Review

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Abstract

X-ray diffraction method has been used by many researchers in order to study the structure of films. In this work, amorphous structure or polycrystalline magnesium oxide thin films could be identified using this technique. Furthermore, the grain sizes could be measured using X-ray diffraction data as well.

Keywords: Magnesium oxide, Thin films, Semiconductor, Deposition, Grain size

Introduction

Oxide materials [1-12] and metal chalcogenide thin films [13-21] are widely employed in the producing of solar cells, sensor devices, laser devices, optoelectronics devices, integrated circuits, and microelectronics. There are many groups of scientists from different countries involved to study these materials [22-29].

In this work, magnesium oxide (MgO) films were prepared using various deposition techniques. Magnesium oxide was chosen due to it has a high melting temperature, stable at atmospheric and large yield of secondary electrons during the bombardment by ions. The obtained films will be investigated using X-ray diffraction technique.

Literature Survey

X-ray diffraction (XRD) technique is mostly employed in materials sciences for the measurement of compounds. Many scientists point out some advantages of XRD such as it gives qualitative and quantitative of crystalline compounds [30-36].

Metal organic chemical vapor deposition (MOCVD) method has been used to prepare MgO films as described by Boo et al. [37]. The XRD patterns confirm that the obtained films with high crystalline and a preferred (111) plane on both Si (100) and c-plane sapphire substrates. Similar growth texture was also detected when the films were synthesized using RF ion plating method as proposed by Kenichi et al. [38]. Manin et al. [39] produced MgO films using MOCVD method. The obtained experimental results support that the oxygen low rate and temperature of the substrate were considered to be the most critical in order to determine the structure of samples. Dyachenko et al. [40] have reported that MgO films were deposited onto glass substrate using spray pyrolysis method under various substrate temperatures. The XRD data confirm that the quality of MgO film's textures increases with increasing the substrate temperature from 370 °C to 420 °C. In other case, (200) preferential orientation was observed for the films prepared at 800 °C using sol-gel method as concluded by Ho et al. [41]. Chemical vapor deposition method was used to prepare MgO films as reported by Toshiro et al. [42]. They found that highly (100) orientation can be seen in XRD patterns for the films prepared at a reaction temperature above 450 °C.

XRD technique has been used by Kurtaran et al. [43] in order to investigate the structure of sprayed MgO films. They claim that amorphous structure and polycrystalline nature could be seen for as-deposited films and annealed samples, respectively. On the other hand, Mahadeva et al. [44] discussed the XRD patterns for the MgO films prepared under various oxygen partial pressures in the working gas. They found that the films are mostly amorphous in the as-deposited conditions. However, the MgO peaks are more significantly appear in the films deposited in oxygen partial pressure of 10 % and annealed films.

The grain size could be determined using XRD data. MgO films were prepared using spray pyrolysis at various temperatures (425-525 °C).The grain size indicates a slight increase as the temperature increased as pointed out by Faraq et al. [45]. On the other hand, MgO films were synthesized using spray pyrolysis method by Nisatharaju et al. [46]. The average grain size was calculated and was in the order of nanometer (14nm).

Conclusion

X-ray diffraction analysis was employed as the characterization tool for optimizing the magnesium oxide films growth conditions. The crystalline structure, amorphous and grain size could be determined using this tool.

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Conflict of Interest

Author has declared that no competing interests exist.

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