

Electrodeposition of Epitaxial ZnSe Films on (111) InP and (100) GaAs from an aqueous Selenosulfate Solution

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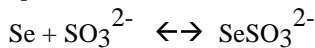
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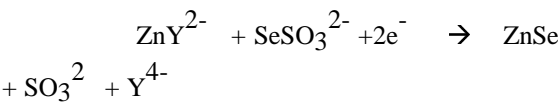
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Epitaxial thin film heterostructures involving wide band gap semiconductors are widely studied for optoelectronic applications like UV light emitting diodes or laser diodes. III-V compounds like gallium nitride and II-VI compounds based on ZnSe are in a leading position. As compared to vapor phase methods, deposition methods from solutions remain to be explored. In this paper we investigate the epitaxial electrodeposition of zinc selenide. Very few works have been devoted to the field of epitaxial growth of compound semiconductor by electrodeposition (CdSe, CdTe, CdS, ZnO) and, up to now, there is no report about epitaxial growth of ZnSe by electrodeposition.

The electrodeposition of ZnSe has been achieved by using the unique properties of sulfite ions to complex elemental selenium in aqueous solution to form selenosulfate ions due to the following equilibrium:



In that case the electrodeposition of ZnSe proceeds by the following electrochemical reaction:



where Y stands for the EDTA anion. The deposition is made in slightly basic conditions at 80°C. When the deposition is made on tin oxide coated glass, the films are polycrystalline but epitaxial growth has been achieved on single crystalline InP (111) and GaAs (100) substrates. The epitaxy is observed over a large range of applied potential (-1.6 to -1.9 V vs Mercury Sulfate Electrode).

The deposition of stoichiometric films have checked by using EDX and RBS techniques.

Epitaxy has been characterized by using the RHEED technique, for different azimuths. Best results tended to be obtained for low cathodic potentials. These results are confirmed by glancing angle XRD analysis. In 360° scan with 0.6° glancing angle, mounted for detecting the reflections of (111) planes, three intense peaks appears which are attributed to the (111) InP

substrate reflections. Three other weak peaks exactly spaced 60° apart are also observed are related to (111) reflections of the ZnSe epitaxial film. The full width at half maximum of these peaks is around 3.5°. The fact that the peak positions for ZnSe coincide with those of InP indicates the <1-10> inplane directions coincide for both compounds.

Similar results are obtained with (100) GaAs substrate, with the growth of cubic ZnSe with (100) in plane orientation. This shows that the epitaxial growth is not only achieved when the growth direction coincides with the <111> texture axis usually obtained by electrodeposition of chalcogenide materials, but extends to the other directions.

In conclusion, the electrochemical method for epitaxial growth of II-VI semiconductor films has been extended to ZnSe on GaAs and InP, using a specially designed electrolyte based on the use of selenosulfate ions as precursors. This precursor prevents the codeposition of elemental selenium which hinders the growth of ZnSe crystals. The solutions are very stable, thanks to the use of a strong complexing agent for zinc cations, and easy to prepare. Electrochemically deposited ZnSe epitaxial films may be interesting for device performances due to specific interface chemistry with the substrate, as formed in a solution environment. The selenosulfate route appears as a very versatile approach for the deposition of high quality selenide semiconductors.

Acknowledgments

This work has been carried out within the cooperation program ECOS between Chile and France(project C00E02) and also supported a FONDECYT project under N° 8000022.

