EPITAXIAL ELECTRODEPOSITION OF ZnSe ON (111) AND (100) InP FROM SELENIUM/DMSO SOLUTIONS

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In this work we report the epitaxial electrodeposition of zinc selenide -a direct transition semiconductor ($E_g \cong 2.68$ eV)- on single crystalline (111) and (100) InP employing a non aqueous solution. The deposition at constant potential has been achieved dissolving elemental selenium in DMSO at a temperature of 423.15 K, using LiCl as supporting electrolyte and $ZnCl_2$ as a zinc source. A similar approach has been recently reported for the electrodeposition of nanocrystaline ZnSe films[1]. The electrochemical reaction accounting for zinc selenide formation is given by:

$$Se°\text{-}DMSO + Zn^{2+} + 2e^{-} \longleftrightarrow ZnSe + DMSO$$

The Zn / Se atomic ratio of the as deposited films indicates that the composition is almost stoichiometric in a wide potential interval (Table1). This is a significant improvement as compared with films obtained from aqueous acid solutions that always produces a large selenium excess. These results are very similar to those recently reported by us for the epitaxial ZnSe films grown on single crystalline InP and GaAs from an aqueous zinc sulfate-selenosulfate solution[2]. Fig. 1 shows the RHEED images obtained for films grown in both substrates at –1.15 V. The dot patterns demonstrate that the films are epitaxials. Similar results were observed for the set of deposition potentials specified in Table 1. The dot positions can be indexed as cubic ZnSe (a= 0.5667 nm). Further, AFM images obtained at -1.15 V on (100) InP confirms the cubic growth of ZnSe in this substrate (Fig 2). Supplementary dots present in both images can be attributed to the presence of twins in the films. The absence of rings indicates that no polycrystalline ZnSe is present in the films.

In conclusion, the electrochemical approach for growing epitaxial ZnSe films starting from elemental selenium dissolved in DMSO has been successfully demonstrated. These promising results open the possibility of obtaining high quality thin layers of the compound that may be useful for designing high performance optoelectronic devices.

References

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Table 1: Atomic ratio of as deposited ZnSe films from EDX analysis. q: -1.0 C cm^{-2}.

-Ed / V vs. ESM	**Zn / Se**	
	InP (111)	**InP (100)**
1.10	0.95	0.97
1.20	0.94	0.94
1.30	0.96	0.95
1.40	0.93	0.94

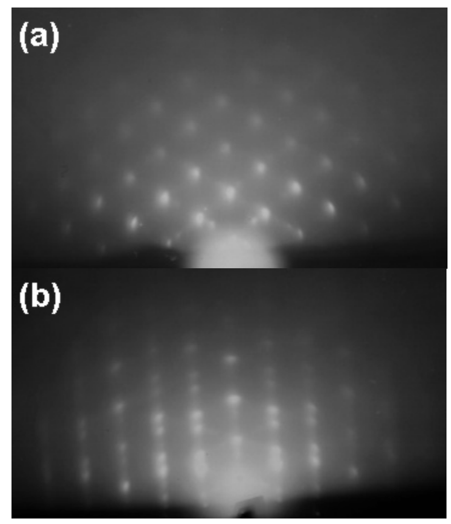

Fig. 1: RHEED images of ZnSe on (a) InP (100) and (b) InP (111) obtained at –1.15 V vs. ESM.
q : -1.0 C cm^{-2}.

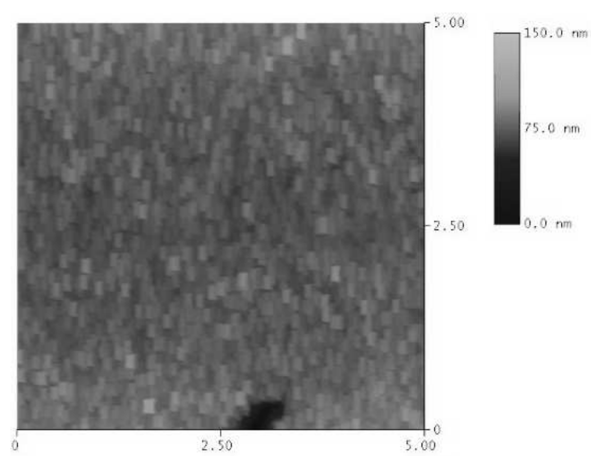

Fig. 2: AFM image for as deposited ZnSe on InP (100) at –1.15 V vs. ESM. q : -1.0 C cm^{-2}.