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Effects of annealing and different substrate materials on ohmic contact property of IGZO films

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Abstract. Amorphous InGaZnO(a-IGZO) films were deposited on the glass substrates with Al/Mo/ITO films separately using magnetron sputtering and photograph methods,to form resistance structures between a-IGZO films and Al/Mo/ITO films.These samples were annealed in the air and N_2 ambience in a series of temperature separately.The results show that regardless of N_2 or air ambience,samples annealing at 250 degrade,IGZO films show a good ohmic contact characteristic with Al/Mo/ITO materials.And,IGZO films have a better ohmic contact characteristic with ITO/Al than Mo. The transmittance of the IGZO films annealed is better than the transmittance of samples without annealing.And ,the transmittance of samples annealed is rising with the increasing of annealing temperature. Considering the optical and electrical properties of IGZO films, we suggest that 250 centi degrades is a suitable temperature for annealing.

Introduction

Thin Film Transistor(TFT) act an important role in the flat panel display area,it is a key part for the display to achive good performance.And, the active layer is the core of TFT.With the increasing of the flat display panel size,the low mobility of amorphous silicon limit the development of FPD.We can prepare microcrystalline silicon,polycrystalline silicon ,metal oxide and so on as the active layer of TFT,to achive high mobility.Compared to silicon films,oxide semiconductor shows high optical transparency,,it could be used to prepare transparent TFT.The transparent TFT have a great of use,it could greatly improve the on/off rate of FPD.If transparent thin film transistor and organic light emitting diode(OLED) are combined together,we can obtain a full transparent electronic display monitor.

At present,many kinds of materials can be used as the active layer of transparent TFT,such as ZnO,IZO,InO,IGZO.IGZO films have many advantages,its bandgap width is about 3.5ev,we can deposite IGZO films at alow temperature,the films is easy to form ohmic contact with other metal materials,IGZO films have good electronic mobility ,and so on.At present ,there is many methods to prepare IGZO films.These methods contain: magnetron sputtering, pulsed laser deposition,electron beam evaporation,and so on.RF magnetron sputtering is the most widely used. It have many advantages,including:high depositing rate, good compactness, films and substrate adhere tightly.As active layer of TFT,the electrical and optical performances of films is very important.In this paper,we prepare IGZO films using RF magnetron sputtering method,and study the principle of the optical and electronic charistic of IGZO films by changing different substrates and different annealing temperatures .

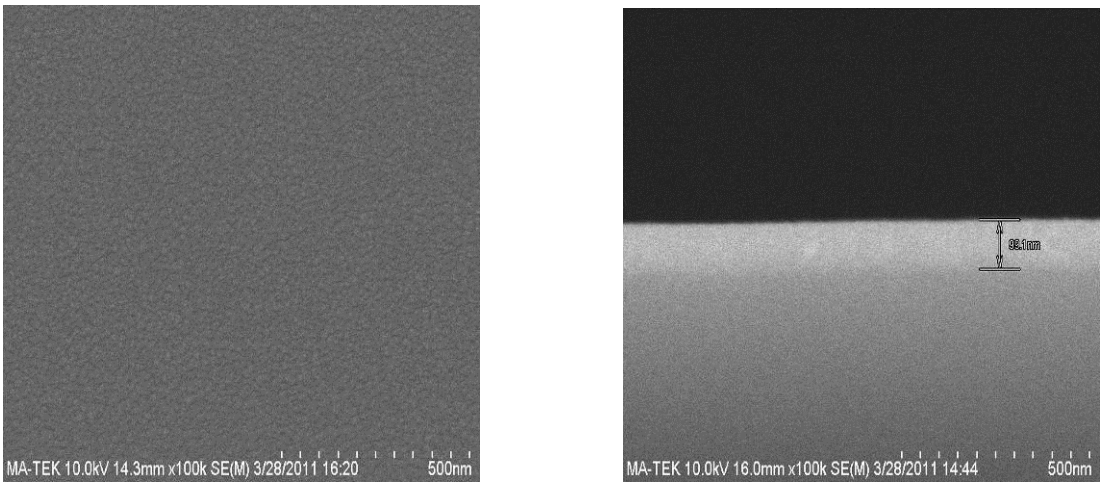
Experimental

a-IGZO films were deposited on unheated glass substrates by ULVAC magnetron sputtering system,the size of glass is 200mm*200mm.The films were prepared in Ar and O_2 ambience,the O_2 flow rate was set at 1.5ml/min,and the process power was set at 300W.The thickness of IGZO films was obtained about 100nm.The chemical composition of the IGZO target was In:Ga:Zn=1:0.9:0.8 in

atomic ratio.The electrical charistic of all samples were conducted by semiconductor parameter analyzer(Agilent HP 4155C) at room temperature. The scanning electronmicroscopy(SEM Hitachi S4800) was used to analyse the surface morphology.The optical transmission of the IGZO films was analyzed by UV/VIS spectrophotometer(U-3000 spectrophotometer).

Result and discussion

2.1 Figure1 shows the typical surface SEM images of IGZO films.over the morphology,we can see that the films reveal a very smooth and a uniform grain size,indicating that the films show the amorphous structures.



(a)Top view (b)Section view

Fig.1 SEM micropraphs for a typical IGZO film

2.2 Figure 2 shows the optical transmission spectra of the IGZO films ranging from 200nm to 800nm with different annealing temperature.It indicate that the trassmittance of the IGZO films without annealingis the most low .And,the transmittance of the samples are almost the same as the annealing temperature growinkg up.

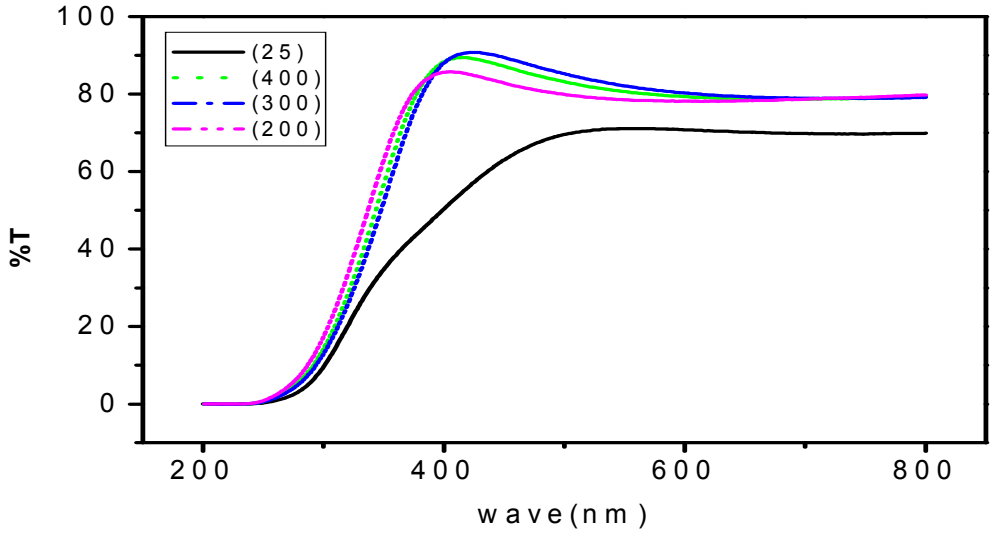


Fig.2 Optical transmission of IGZO films deposited with different annealing temperature

2.3 Figure 3 shows the I/V curves of Al/IGZO devices annealing in air ambience ,at a series of temperature: 200,250,300,350 and 400 centi degrades.From figure 1 we can see that when the voltage varied from -1V to 1V,the current of the Al/IGZO device without annealing is the most small,the

order of magnitude is about 10E-8. And,the current of the Al/IGZO device annealing at 250 centi degrades is the biggest, the order of magnitude is about 10E-4. As the annealing temperature varied from200 to 400,the current of Al/IGZO device growed larger firstly, when the temperature was 250 centi degrades,the current reached the maxmum point,then gradually became smaller with the continue increasing of the temperature.

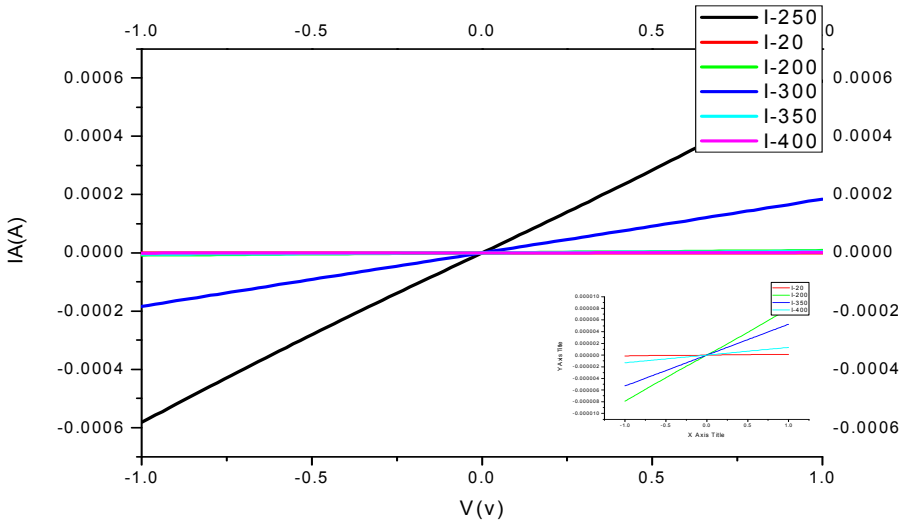


Figure.3 The I/V curves of Al/IGZO devices annealing in air ambience

Figure 4 shows the I/V curves of Al/IGZO devices annealing in N_2 ambience ,at a series of temperature: 200,250,300,350 and 400 centi degrades. From figure 4 we can see that when the voltage varied from -1V to 1V,the current of the Al/IGZO device annealing at 200 centi degrades is the most small,the order of magnitude is about10E-8. And,the current of the Al/IGZO device annealing at 250 centi degrades is the biggest, the order of magnitude is about 10E-4. As the annealing temperature varied from 200 to 400,the current of Al/IGZO device annealing in N_2 ambience growed larger firstly, when the temperature was 250 centi degrades,the current reached the maxmum point,then gradually became smaller with the continue increasing of the temperature.

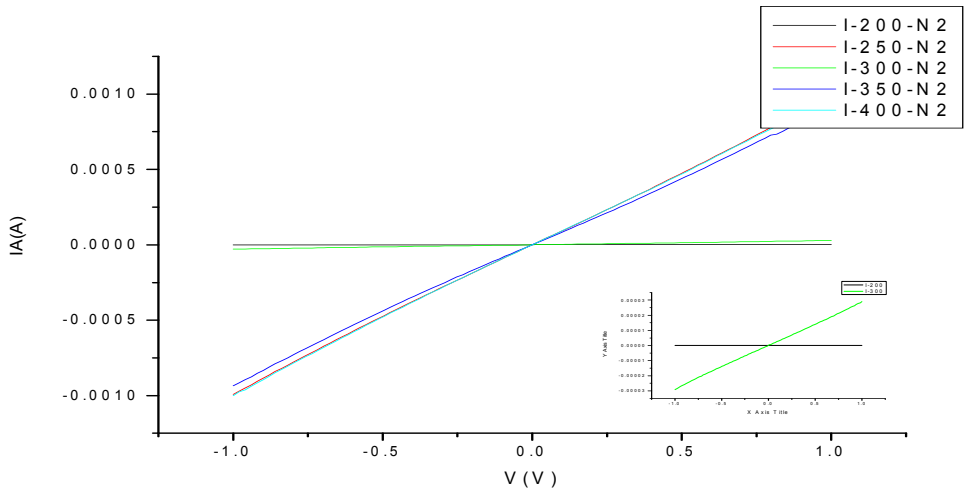


Figure.4 The I/V curves of Al/IGZO devices annealing in N_2 ambience

Figure 5 shows the I/V curves of ITO/IGZO devices annealing in air ambience ,at a series of temperature: 200,250,300,350 and 400 centi degrades. From figure 3 we can see that when the voltage varied from -1V to 1V,the current of the ITO/IGZO deviceannealing at 200 centi degrades is the most

small,the order of magnitude is about 10E-8. And,the current of the Al/IGZO device annealing at 250 centi degrades is the biggest, the order of magnitude is about 10E-4. As the annealing temperature varied from 200 to 400,the current of Al/IGZO device annealing in N_2 ambience growed larger firstly, when the temperature was 250 centi degrades,the current reached the maxmum point,then gradually became smaller with the continue increasing of the temperature.

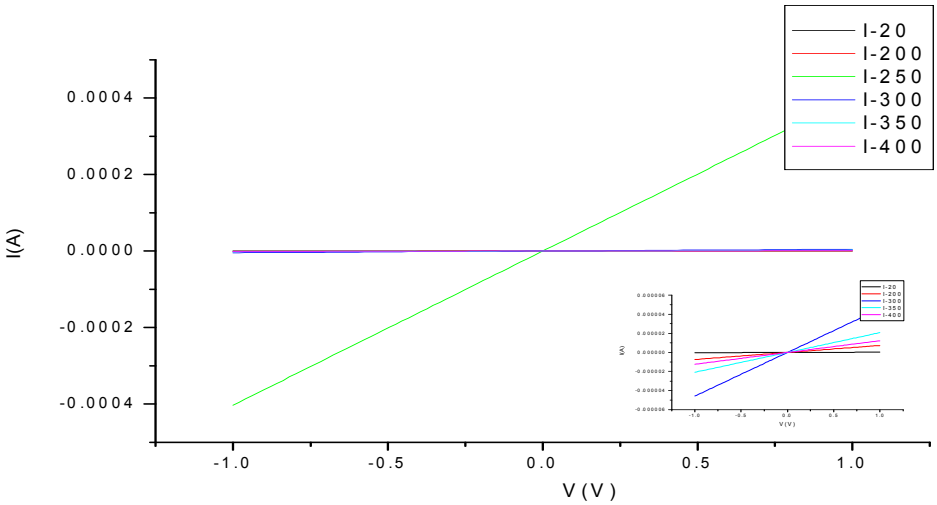


Figure.5 The I/V curves of ITO/IGZO devices annealing in air ambience

Figure 6 shows the I/V curves of ITO/IGZO devices annealing in N_2 ambience ,at a series of temperature: 200,250,300,350 and 400 centi degrades. From figure 6 we can see that when the voltage varied from -1V to 1V,the current of the ITO/IGZO deviceannealing at 200 centi degrades is the most small,the order of magnitude is about 10E-5. And,the current of the ITO/IGZO device annealing at 250 centi degrades is the biggest, the order of magnitude is about 10E-4. As the annealing temperature varied from 200 to 400,the current of ITO/IGZO device annealing in N_2 ambience growed larger firstly, when the temperature was 250 centi degrades,the current reached the maxmum point,then gradually became smaller with the continue increasing of the temperature.

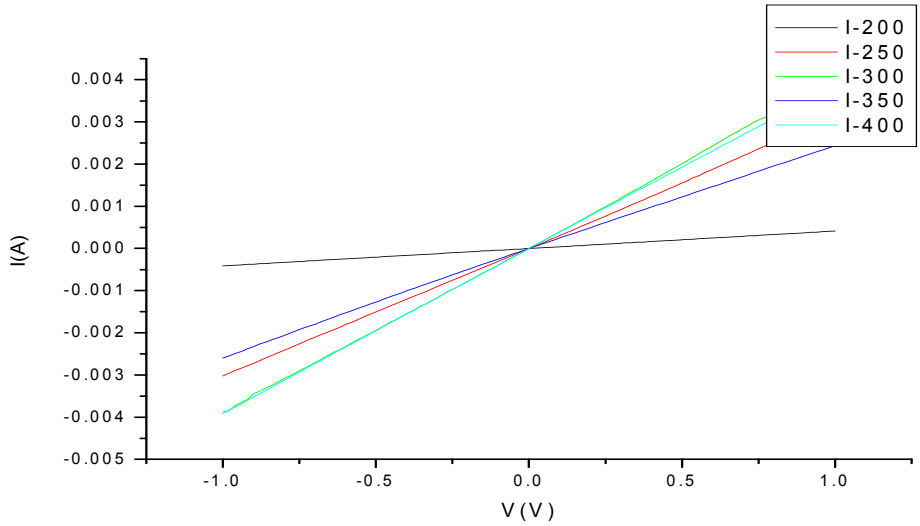


Figure.6 The I/V curves of ITO/IGZO devices annealing in N_2 ambience

Figure 7 shows the I/V curves of Mo/IGZO devices annealing in air ambience ,at a series of temperature: 200,250,300,350 and 400 centi degrades.From figure 7 we can see that when the voltage varied from -1V to 1V,the current of the Mo/IGZO device without annealing is the most small,the

order of magnitude is about 10E-8. And,the current of the Al/IGZO device annealing at 250 centi degrades is the biggest, the order of magnitude is about 10E-4. As the annealing temperature varied from 200 to 400,the current of Al/IGZO device growed larger firstly, when the temperature was 250 centi degrades,the current reached the maxmum point,then gradually became smaller with the continue increasing of the temperature.

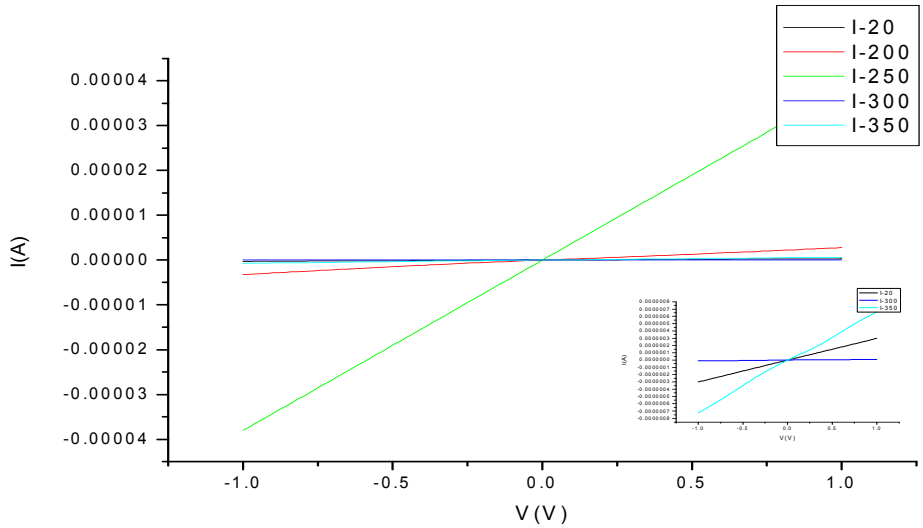


Figure.7 The I/V curves of Mo/IGZO devices annealing in air ambience

Figure 8 shows the I/V curves of Mo/IGZO devices annealing in N2 ambience ,at a series of temperature: 200,250,300,350 and 400 centi degrades. From figure 8 we can see that when the voltage varied from -1V to 1V,the current of the Mo/IGZO device annealing at 250 centi degrades is the most small,the order of magnitude is about 10E-4. And,the current of the ITO/IGZO device annealing at 200 centi degrades is the biggest, the order of magnitude is about 10E-3. As the annealing temperature varied from 200 to 400,the current of Mo/IGZO device annealing in N_2 ambience changed in no rules.

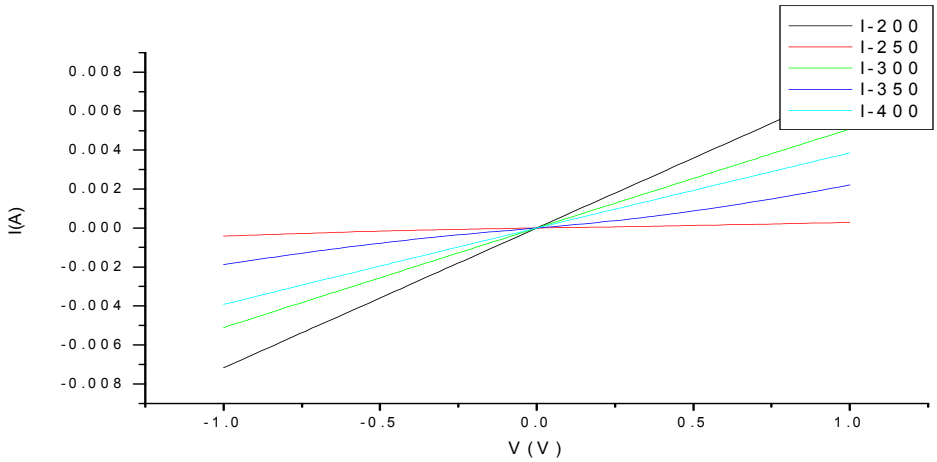


Figure.8 The I/V curves of Mo/IGZO devices annealing in N_2 ambience

Conclusions

We prepare Al/IGZO, Mo/IGZO, ITO/IGZO devices by RF magnetron sputtering method.These devices were annealede in N_2 and air ambience separately. We study the electrical and optical properties of IGZO thin films by these samples.The results show that when the samples annealing at 250 centi degrades. IGZO films show a good ohmic contact.

Acknowledgement

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